



US009423665B2

(12) **United States Patent**  
**Lin et al.**

(10) **Patent No.:** **US 9,423,665 B2**  
(45) **Date of Patent:** **Aug. 23, 2016**

(54) **AMBIENT LIGHT ADJUSTMENT  
APPARATUS, METHOD AND SYSTEM**

(71) Applicant: **Industrial Technology Research  
Institute, Hsinchu (TW)**

(72) Inventors: **Hsueh-Chin Lin**, Taipei (TW);  
**Yi-Shou Tsai**, Taipei (TW); **Chih-Chia  
Chang**, Hsinchu County (TW);  
**Wei-Chen Pao**, Hsinchu County (TW);  
**Kuo-Chung Huang**, Taichung (TW);  
**Ya-Hui Lin**, Hsinchu (TW);  
**Man-Chun Chu**, Chiayi County (TW);  
**Louis Lu-Chen Hsu**, Taipei (TW)

(73) Assignee: **Industrial Technology Research  
Institute, Hsinchi (TW)**

(\*) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 123 days.

(21) Appl. No.: **14/222,693**

(22) Filed: **Mar. 24, 2014**

(65) **Prior Publication Data**  
US 2015/0268529 A1 Sep. 24, 2015

(51) **Int. Cl.**  
**G02F 1/153** (2006.01)  
**G02F 1/163** (2006.01)  
**G02B 26/00** (2006.01)  
(Continued)

(52) **U.S. Cl.**  
CPC ..... **G02F 1/163** (2013.01); **E06B 7/00**  
(2013.01); **E06B 9/24** (2013.01); **G02B 26/005**  
(2013.01); **G02F 1/157** (2013.01); **E06B**  
**2009/2464** (2013.01); **Y10T 29/49002**  
(2015.01)

(58) **Field of Classification Search**

CPC ..... G02F 1/163; G02F 1/157; G02B 26/02;  
E06B 7/00; E06B 9/24; E06B 2009/247;  
E06B 2009/2464

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,212,805 B1 4/2001 Hill  
6,398,370 B1 6/2002 Chiu et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CA 2190969 12/1995  
CN 101541120 9/2009

(Continued)

OTHER PUBLICATIONS

Marie-Claude Dubois et al., "Energy saving potential and strategies  
for electric lighting in future North European, low energy office  
buildings: A literature review", Energy and Buildings, Oct. 1, 2011,  
pp. 2572-2582, vol. 43, Issue 10.

(Continued)

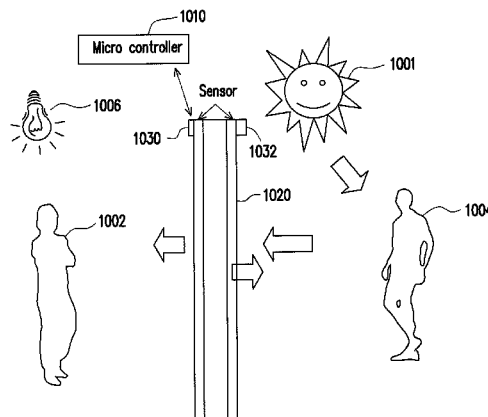
Primary Examiner — Joseph P Martinez

(74) Attorney, Agent, or Firm — Jianq Chyun IP Office

(57) **ABSTRACT**

An ambient light adjustment (ALA) apparatus, a method and  
a system therewith are proposed. The ALA apparatus  
includes a main body having a plurality of edges, one or  
more light sources, a light blocking layer and a controller.  
The light source is mounted on at least one edge of the ALA  
apparatus. The main body comprises at least one light guide  
plate. The light blocking layer is disposed over a surface of  
the main body. The controller is coupled to the light source  
and the light blocking layer. The ALA apparatus further  
comprises at least one sensor coupled to the controller. The  
controller controls the light characteristics of the light source  
and/or the light blockage levels of the light blocking layer to  
adjust ambient light characteristics, according to a sensed  
result by the sensor or sensors.

**30 Claims, 25 Drawing Sheets**



(51)	<b>Int. Cl.</b>		EP	1739473	1/2007
	<b>G02F 1/157</b>	(2006.01)	TW	M344266	11/2008
	<b>E06B 7/00</b>	(2006.01)	TW	M438092	9/2012
	<b>E06B 9/24</b>	(2006.01)	WO	2013019080	2/2013
			WO	2013127212	9/2013
			WO	2013148124	10/2013

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,198,372	B2	4/2007	Aeling et al.	
7,505,188	B2	3/2009	Niiyama et al.	
8,232,958	B2	7/2012	Tolbert	
8,292,467	B2	10/2012	Vissenberg et al.	
2012/0113682	A1	5/2012	Morino et al.	
2012/0127701	A1	5/2012	Brydon, Jr.	
2012/0239209	A1	9/2012	Brown et al.	
2012/0306381	A1	12/2012	Adler	
2012/0307522	A1	12/2012	Ham	
2013/0026504	A1	1/2013	Marx et al.	
2013/0242370	A1	9/2013	Wang	
2014/0185129	A1*	7/2014	Kim .....	H01L 51/5284 359/296

FOREIGN PATENT DOCUMENTS

EP	0703561	3/1996
----	---------	--------

OTHER PUBLICATIONS

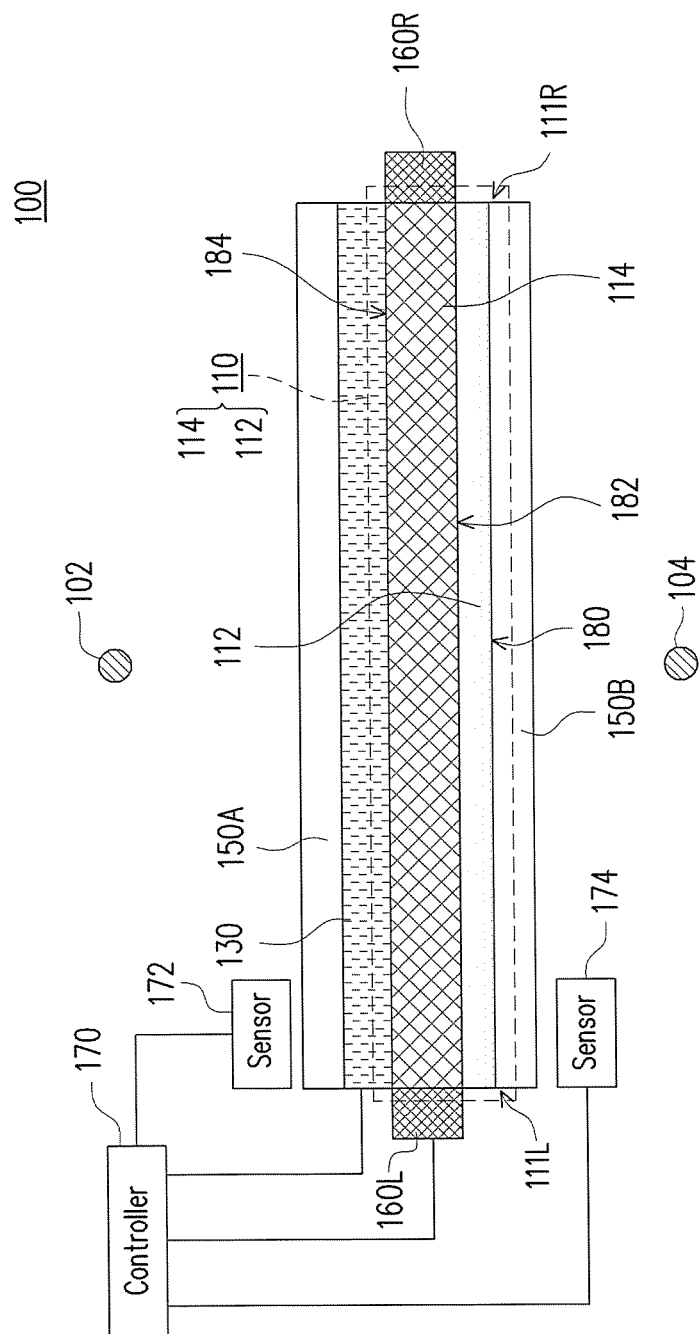
Edmonds et al., "Daylighting in the tropics", Solar Energy, Aug. 2, 2008, pp. 111-121, vol. 73, Issue 2.

Gordon et al., "Large area electrochromics for architectural applications", Journal of Non-Crystalline Solids, Sep. 2, 1997, pp. 342-346, vol. 218.

Wen et al., "Towards embedded wireless-networked intelligent daylighting systems for commercial buildings", IEEE International Conference on Sensor Networks, Ubiquitous, and Trustworthy Computing, Jun. 5-7, 2006, pp. 1-6.

Bhardwaj et al., "Smart lighting using LED luminaries", 2010 8th IEEE International Conference on Pervasive Computing and Communications Workshops (PERCOM Workshops), Mar. 29, 2010-Apr. 2, 2010, pp. 654-659.

\* cited by examiner



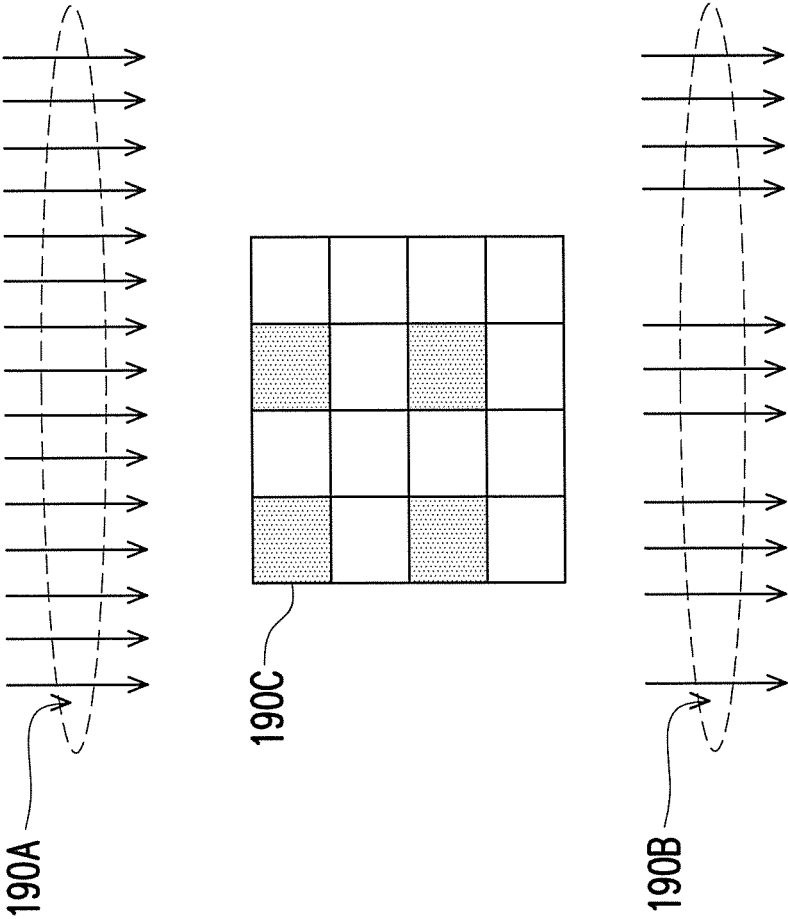


FIG. 1B

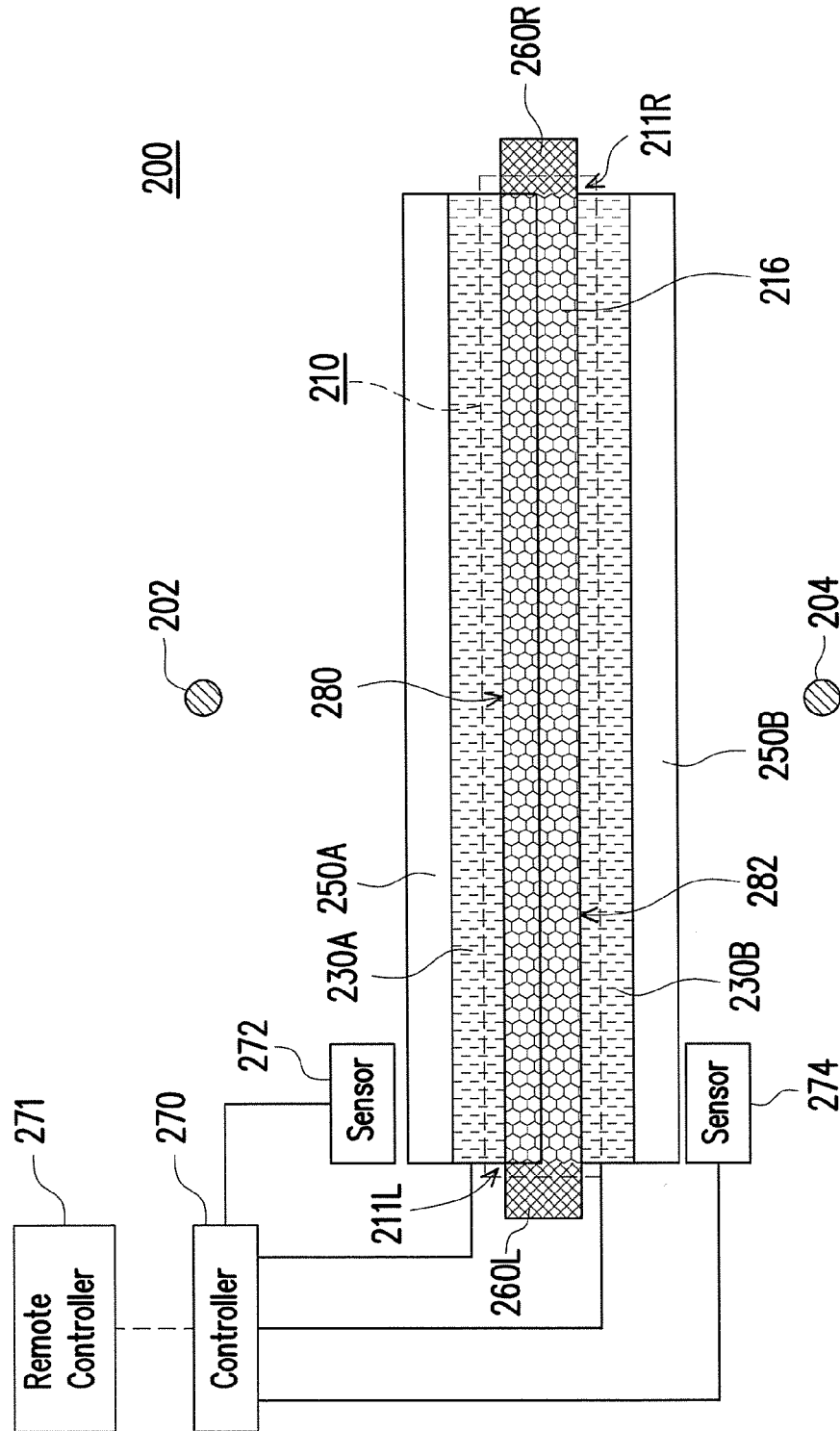


FIG. 2

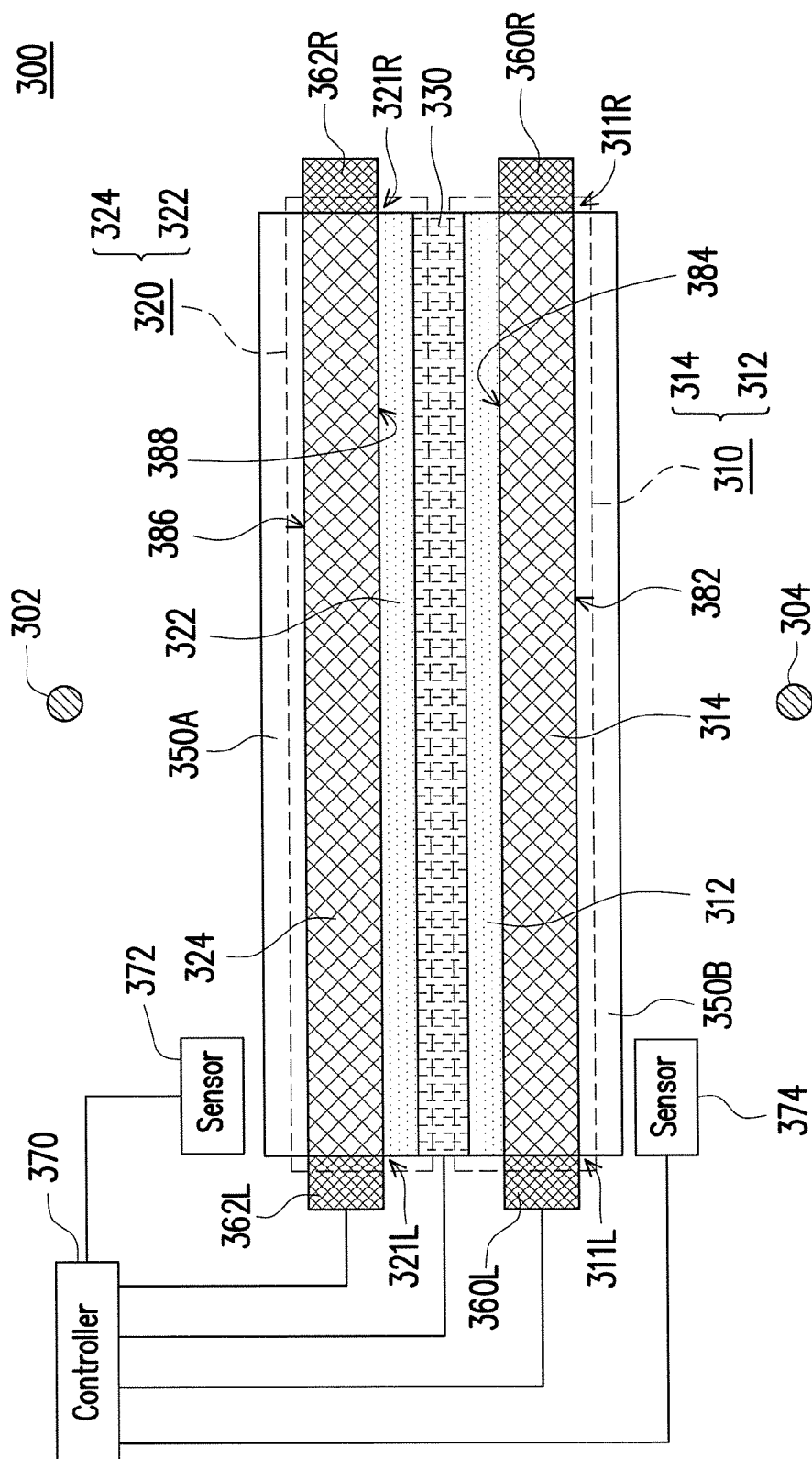


FIG. 3

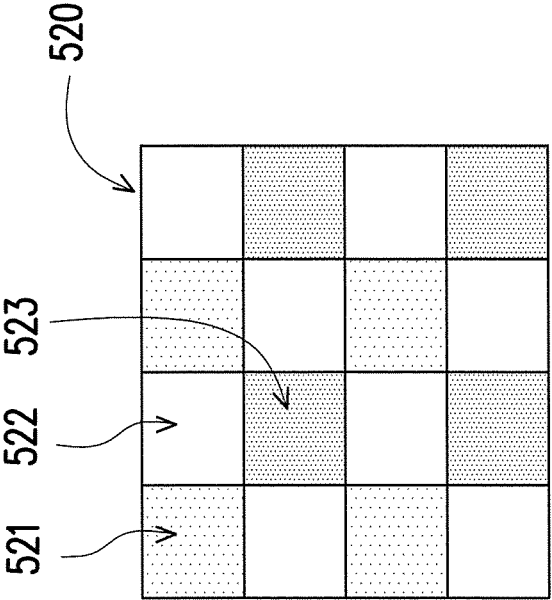


FIG. 4B

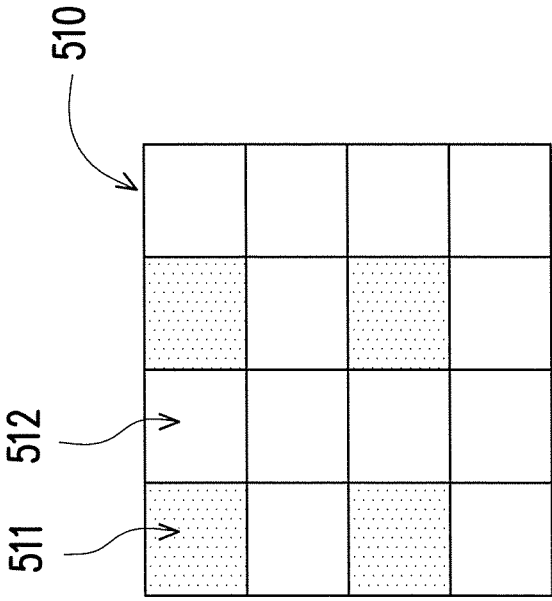


FIG. 4A

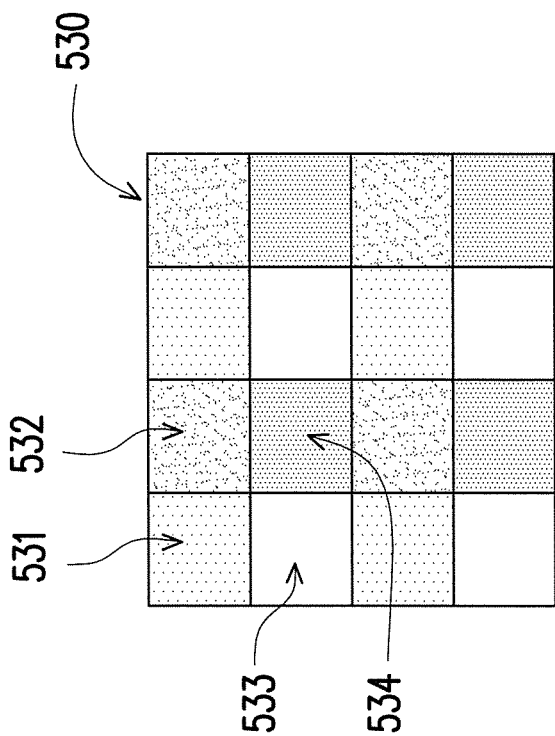


FIG. 4C

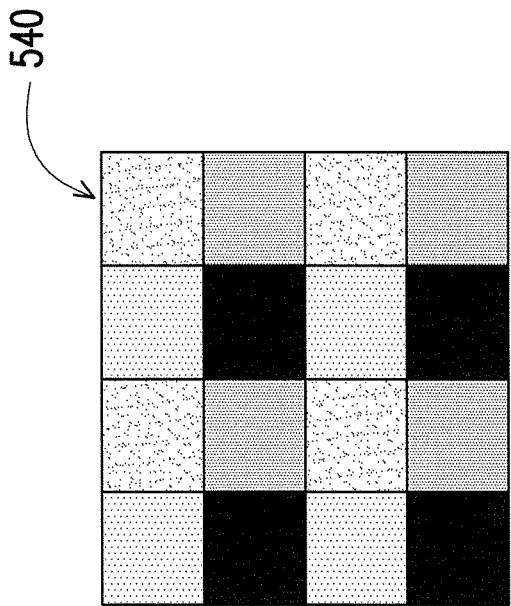


FIG. 4D



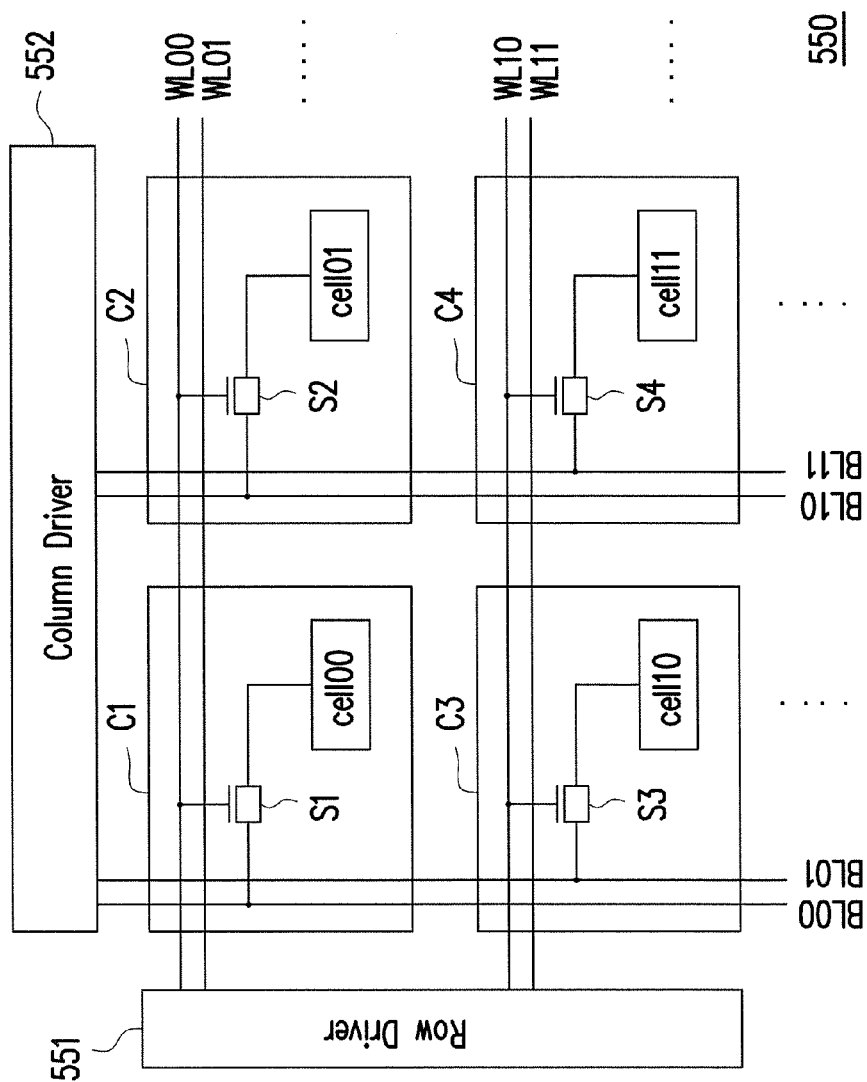


FIG. 5

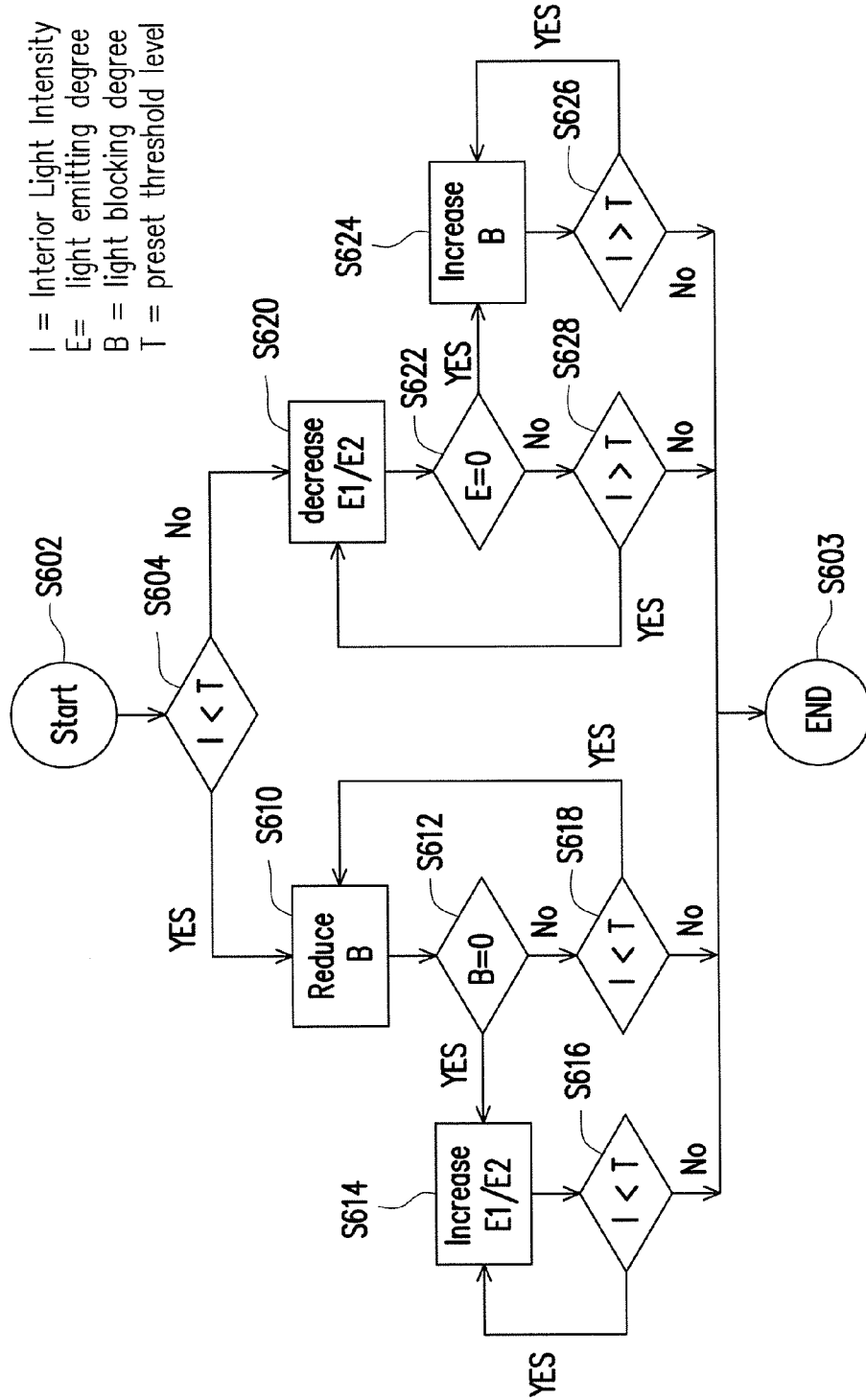


FIG. 6

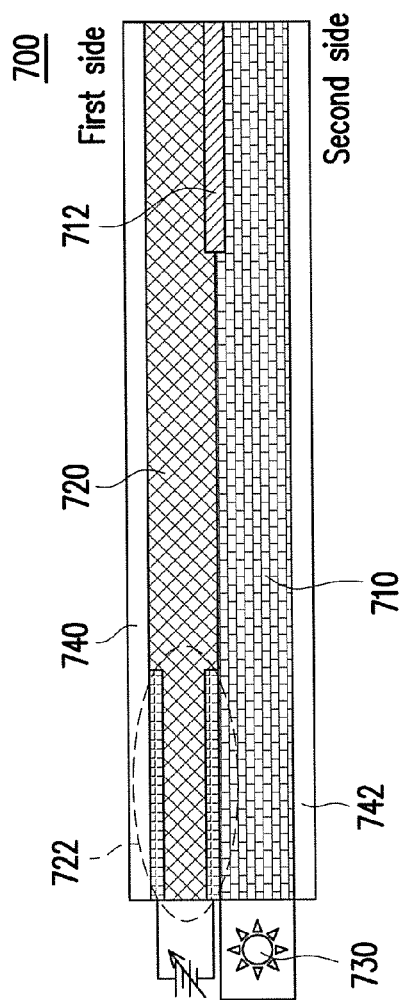


FIG. 7A

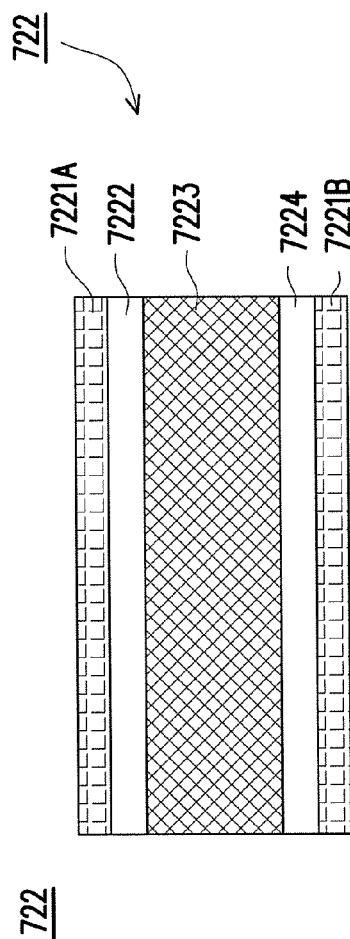


FIG. 7B

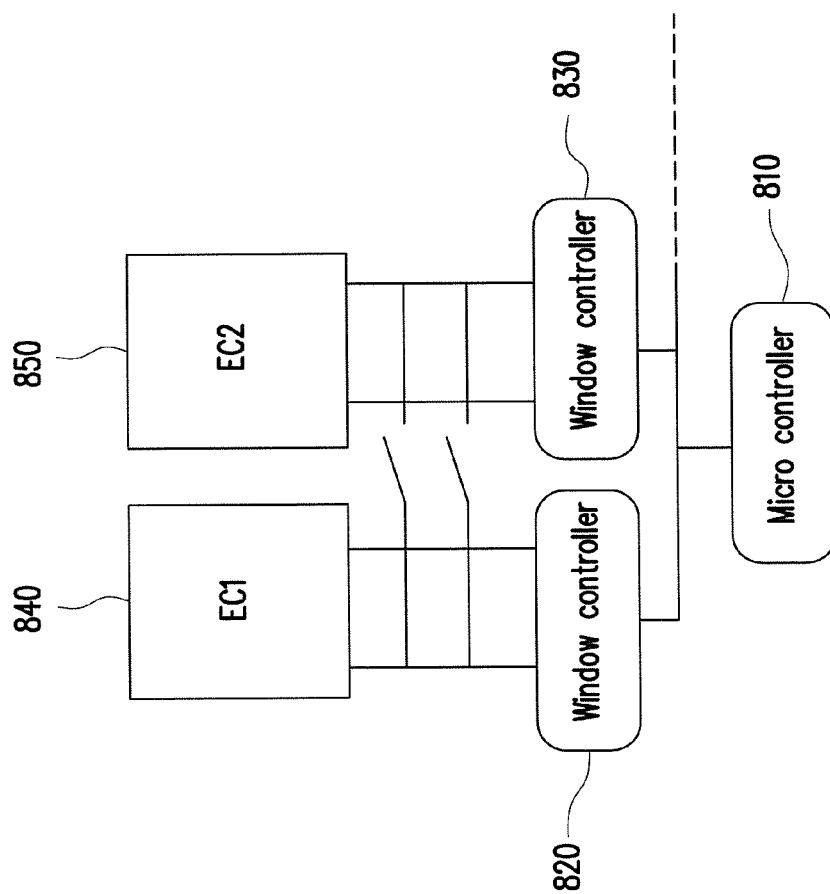


FIG. 8

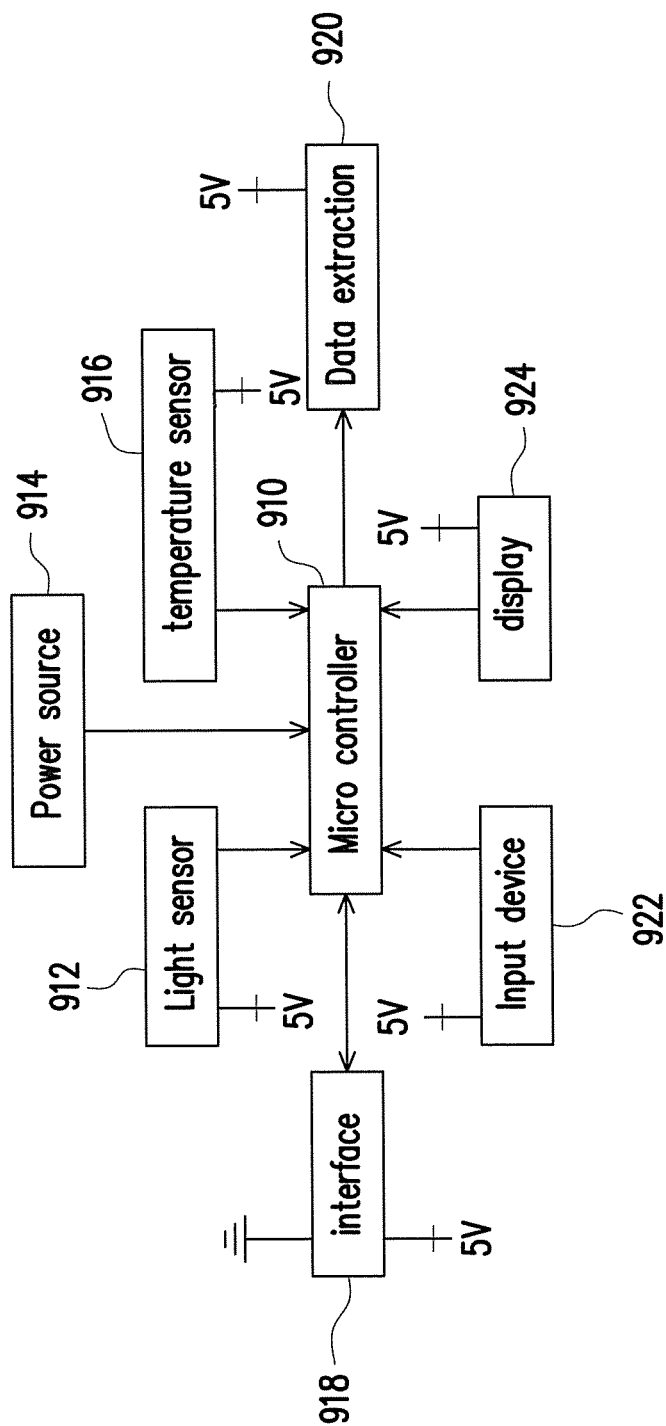


FIG. 9A

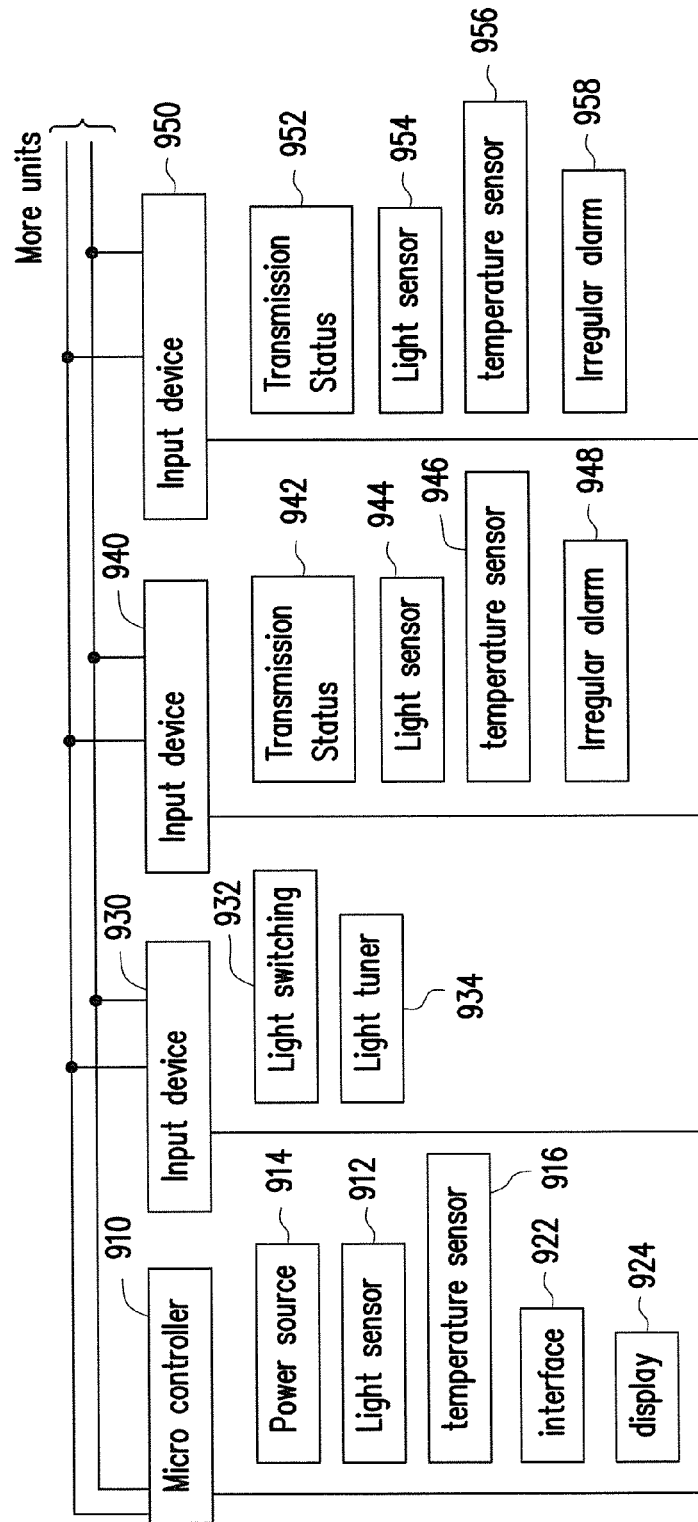


FIG. 9B

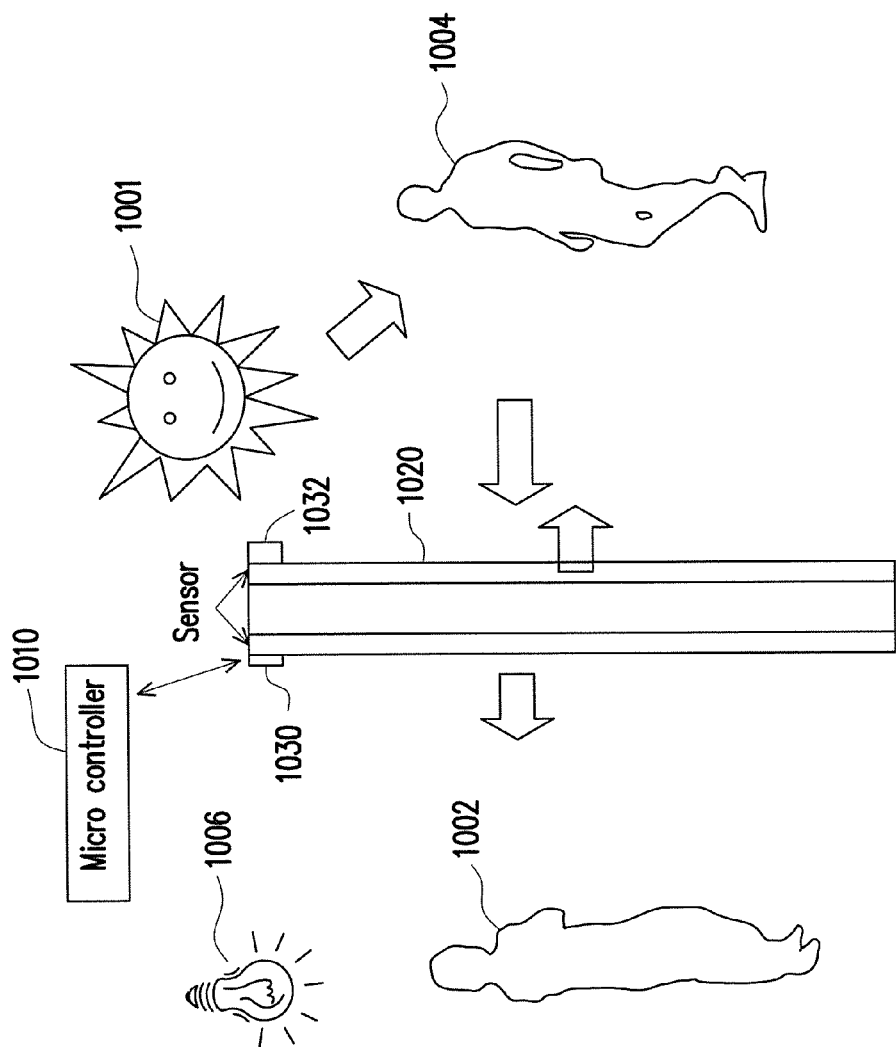


FIG. 10

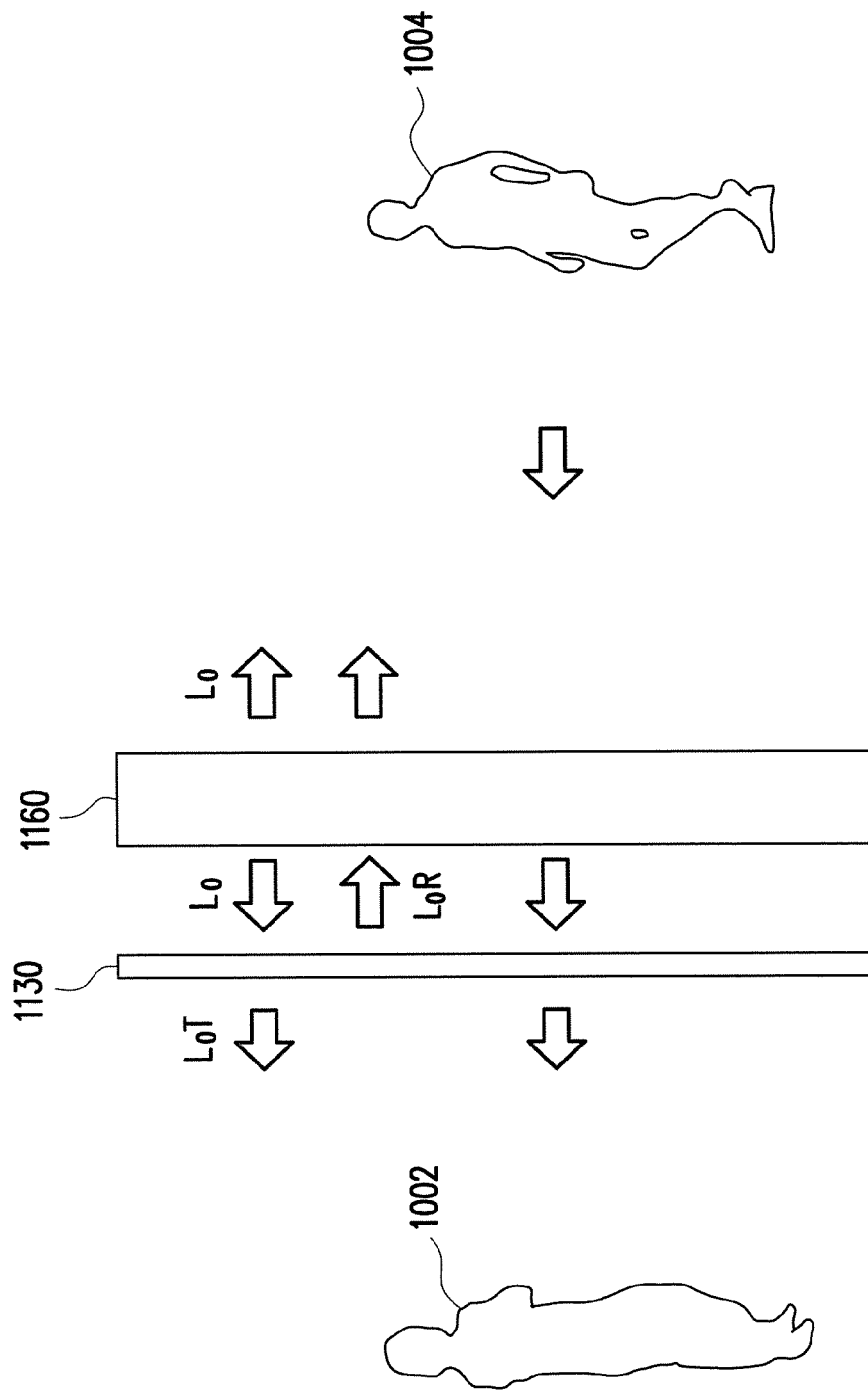


FIG. 11



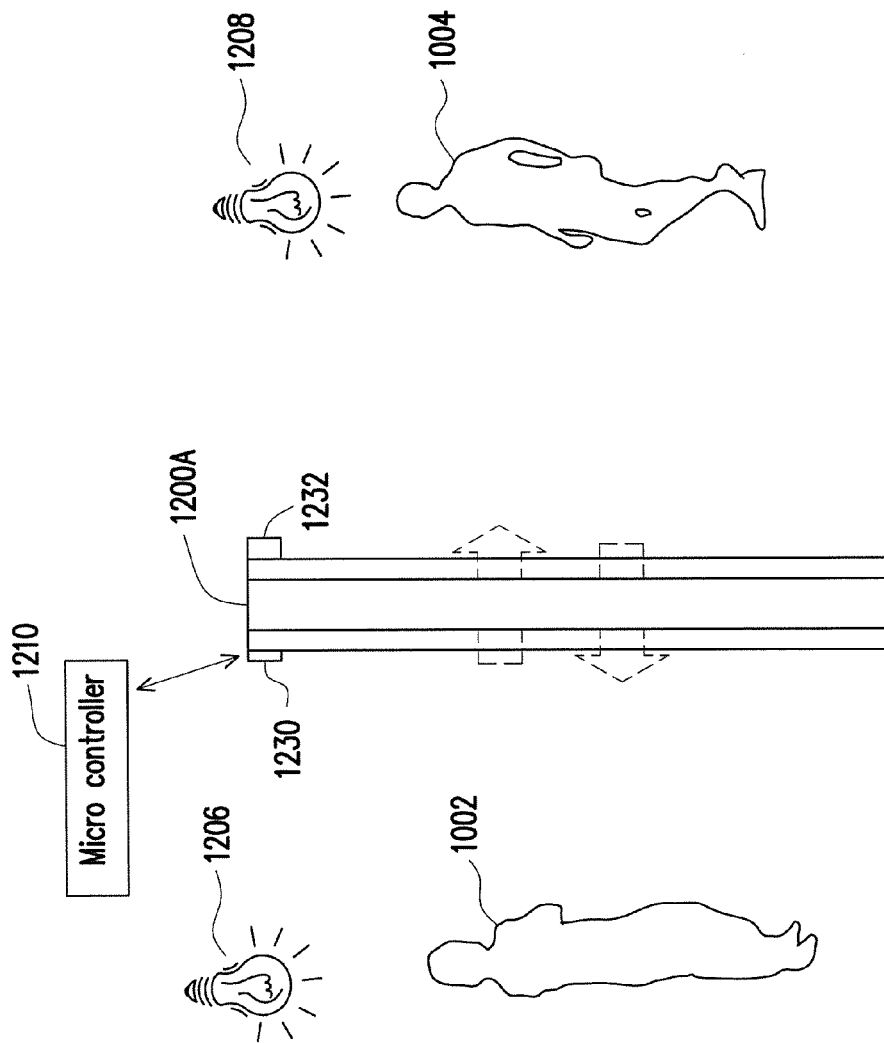


FIG. 12A

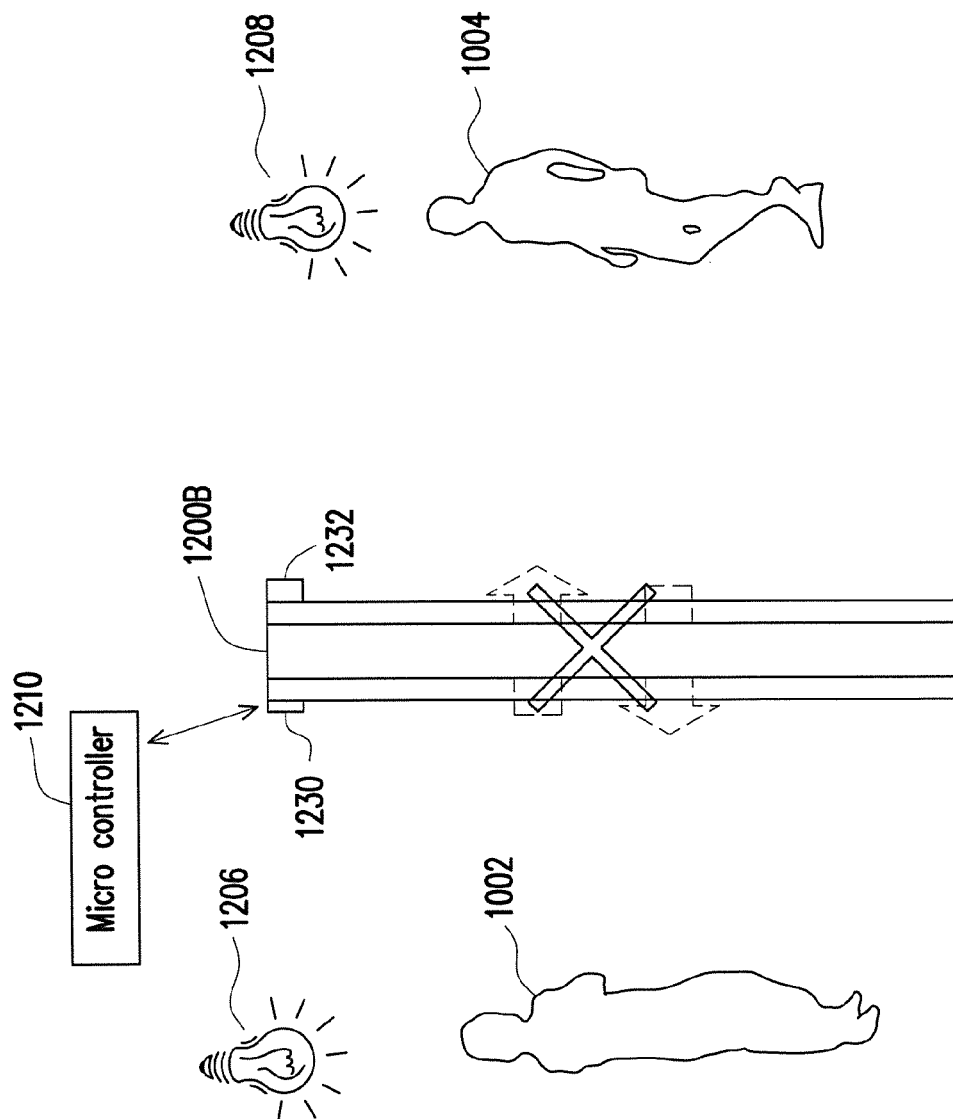


FIG. 12B

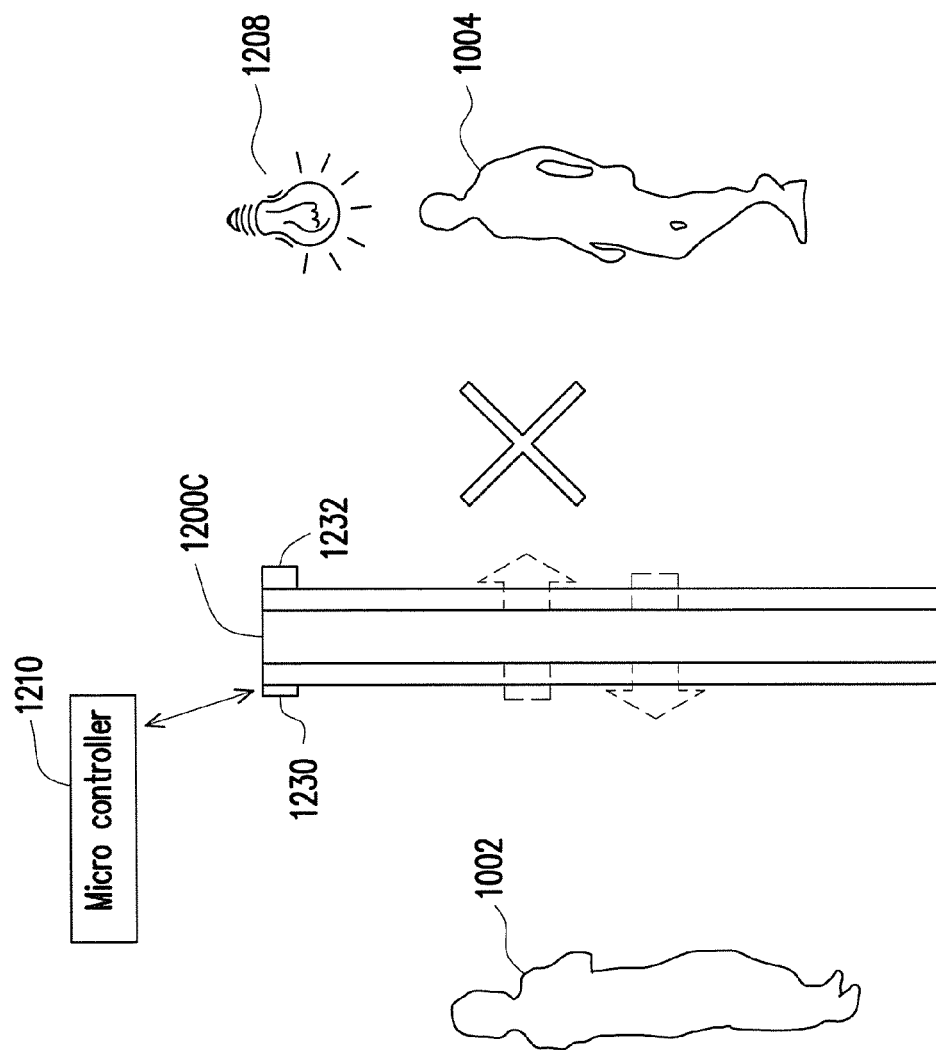


FIG. 12C

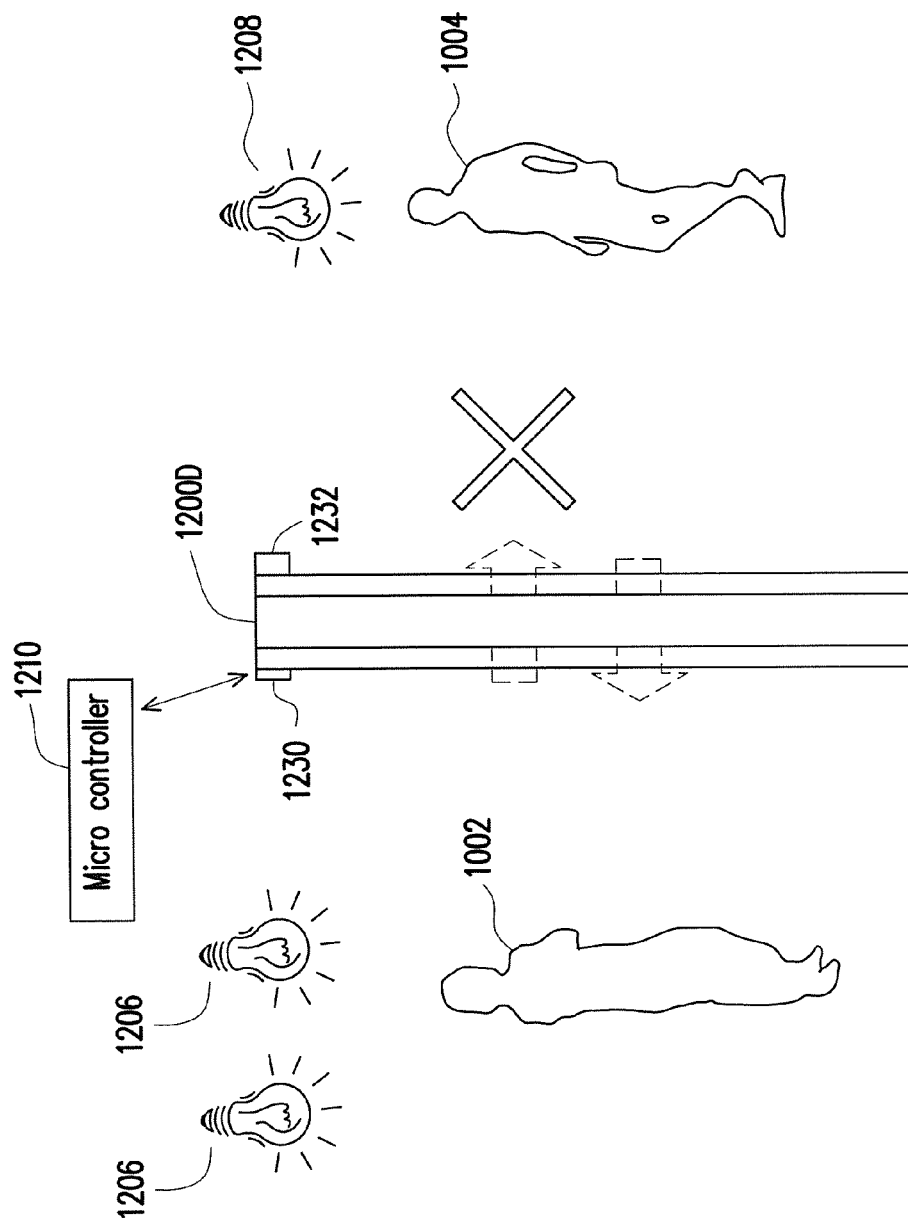
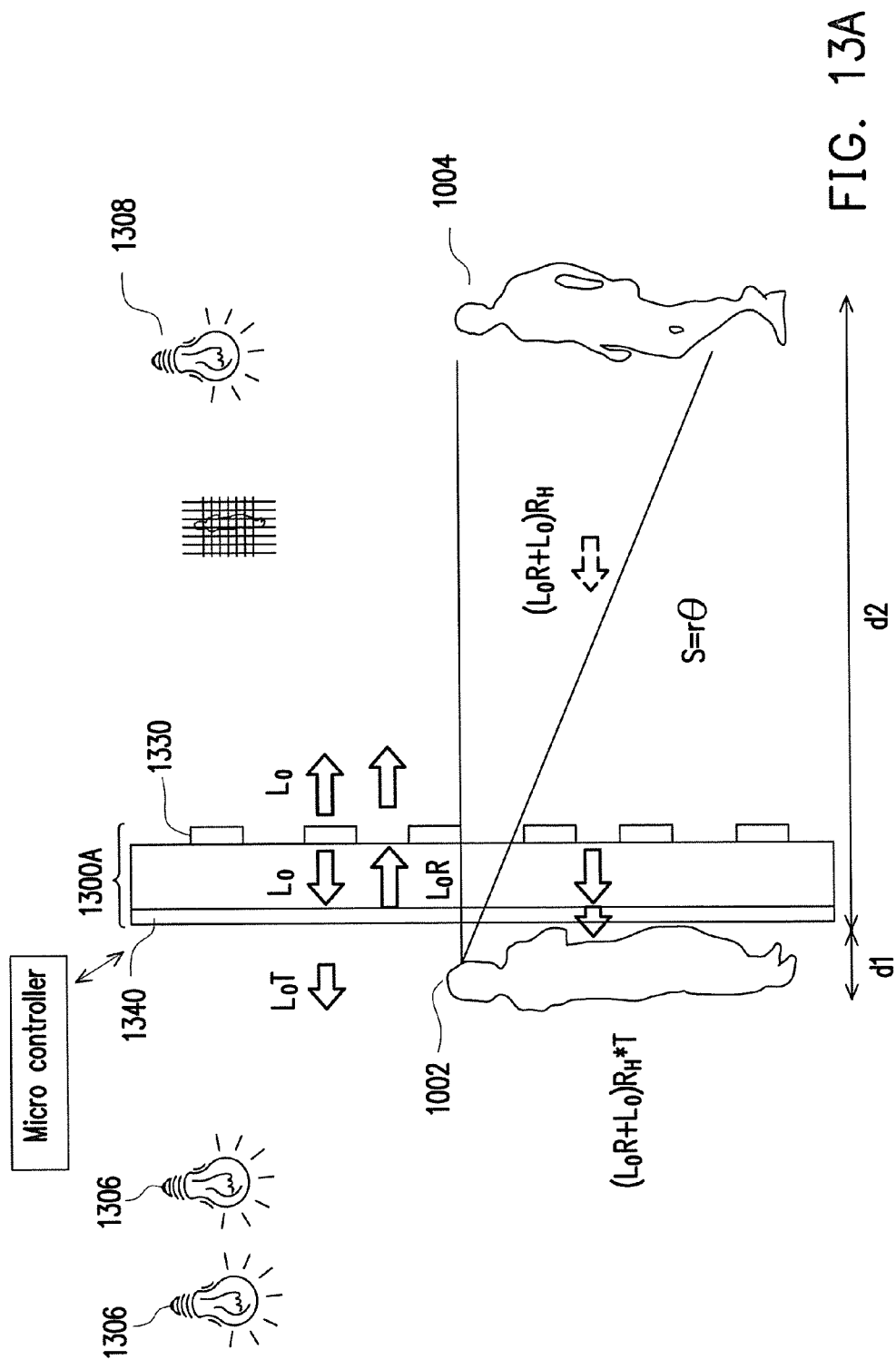
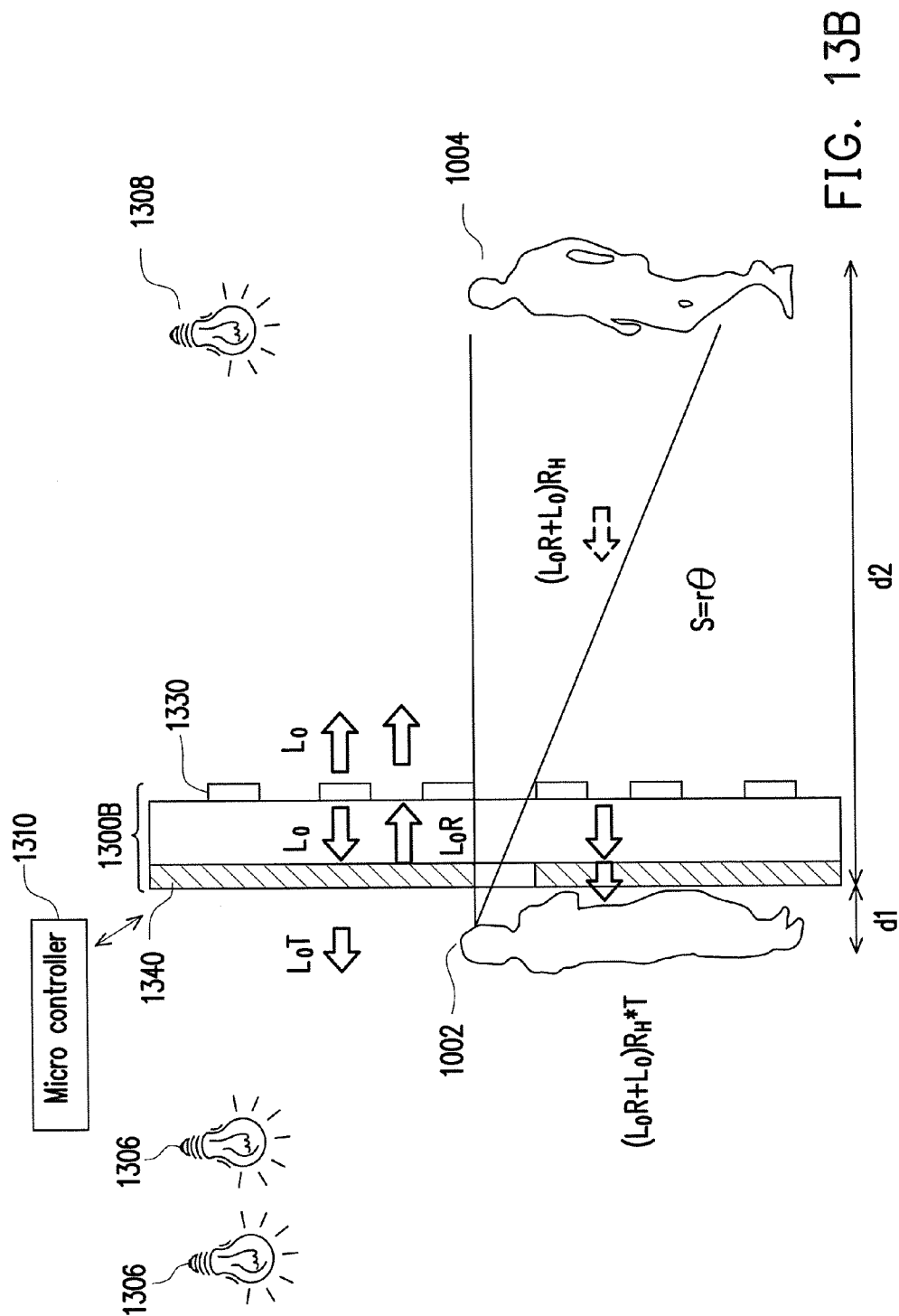


FIG. 12D





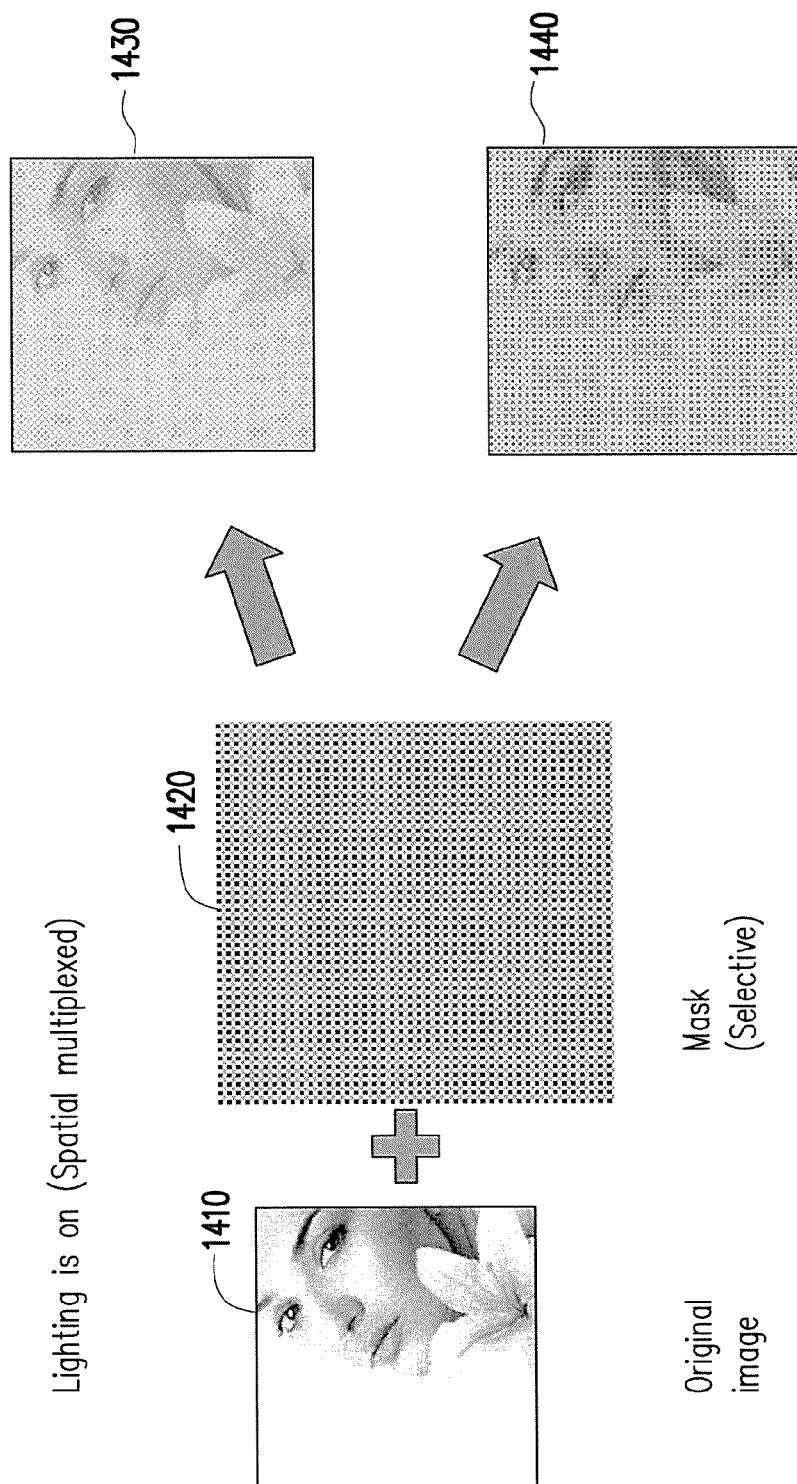


FIG. 14

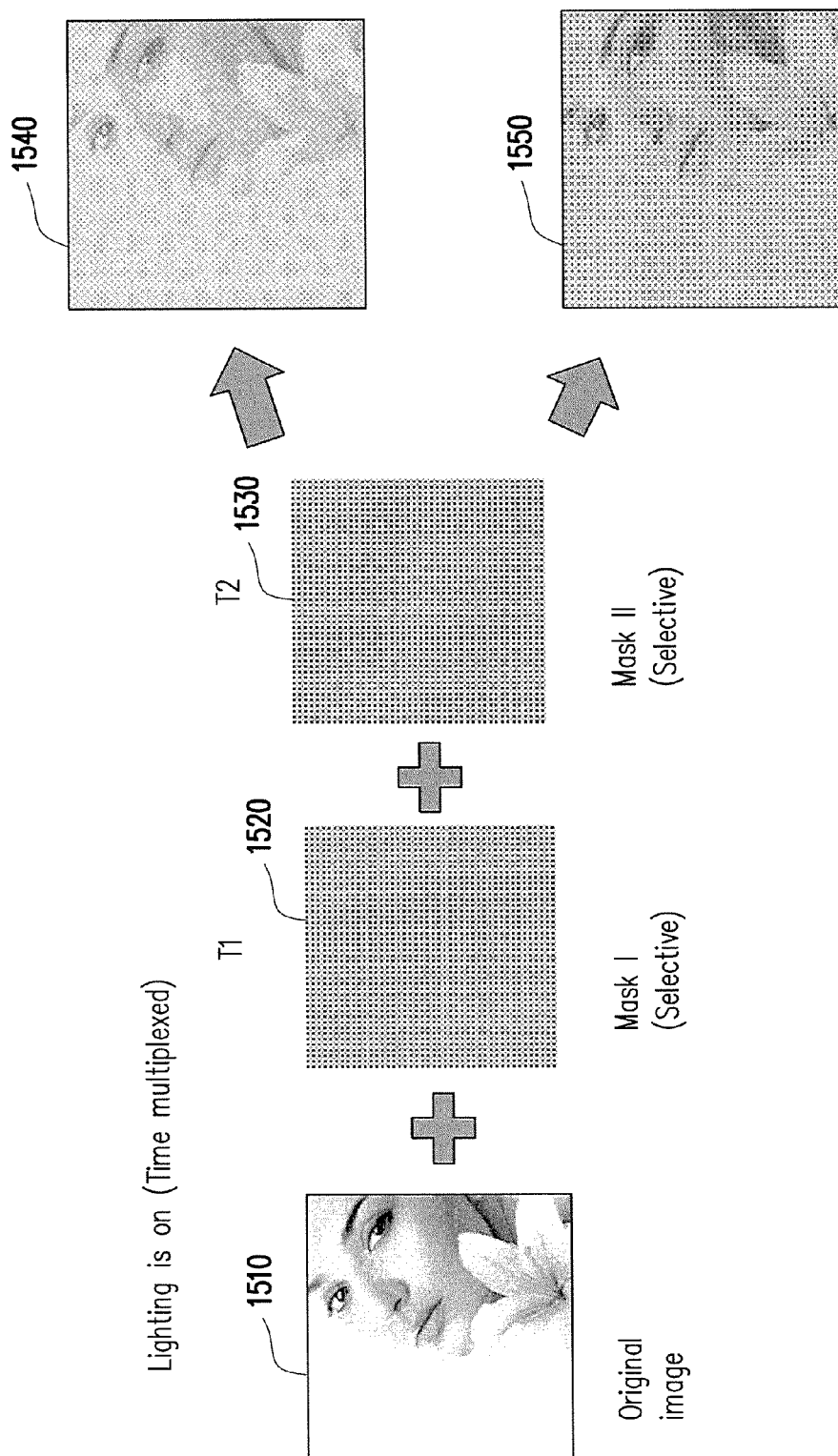


FIG. 15



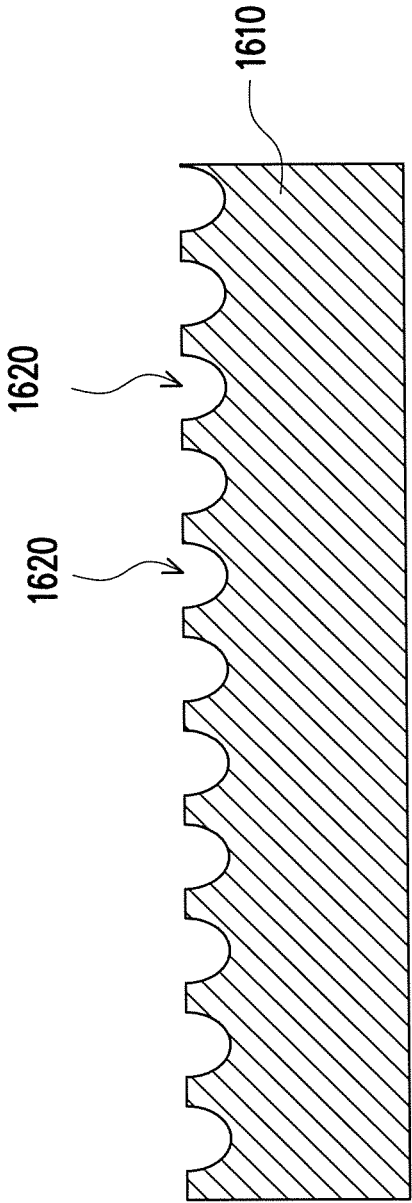


FIG. 16

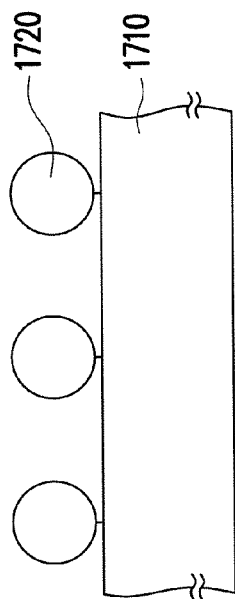


FIG. 17A

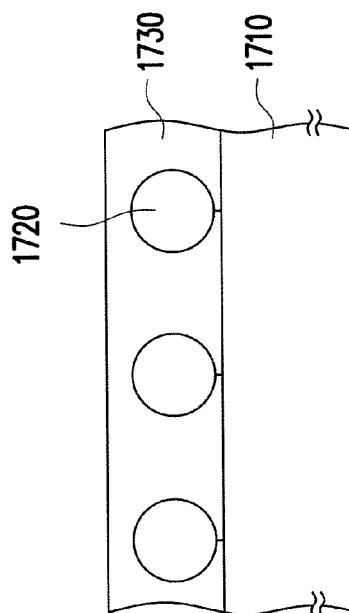


FIG. 17B

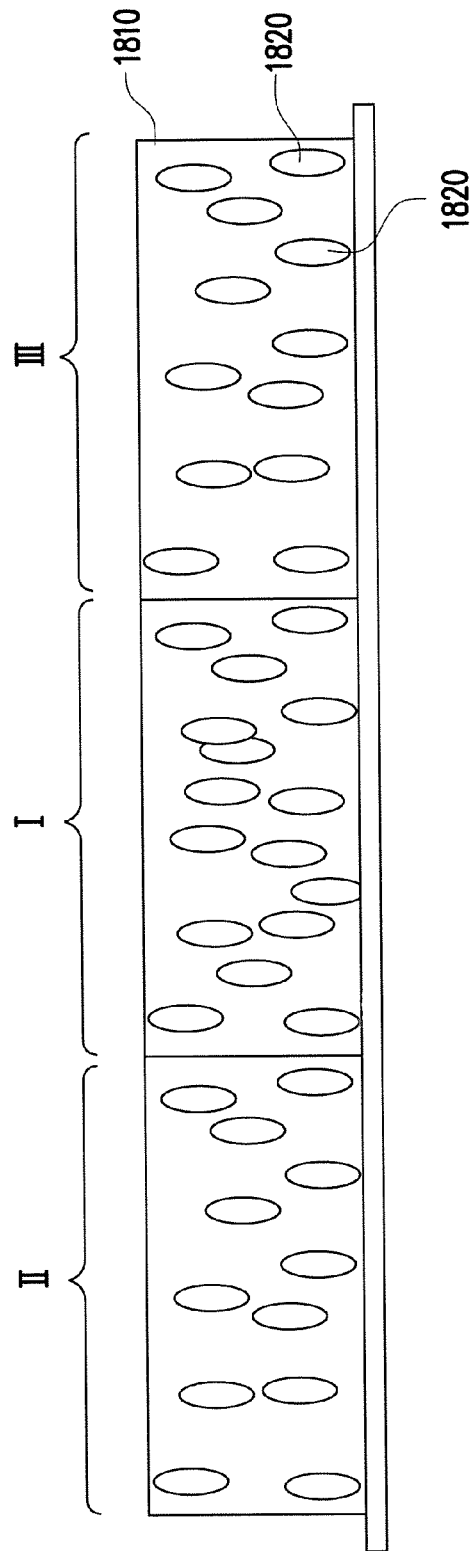


FIG. 18

1

# AMBIENT LIGHT ADJUSTMENT APPARATUS, METHOD AND SYSTEM

## TECHNICAL FIELD

The disclosure generally relates to an apparatus, a method and a system of adjusting ambient light, more particularly, a smart window with ambient light adjustment capability.

## BACKGROUND

Some existing displays are made of a light guide with edge light sources. However, almost all the displays are not transparent enough for window applications. A smart window available today is able for transparency adjustment. The smart window can thus save energy by blocking external heat in the summer time. Some of them are also able for serving as a display. It can be used as a curtain for shielding and preventing outsiders peeking in. However, when the smart window is in its blocking mode, it is not possible for an insider to see out. It is neither able to adjust ambient light when outdoor light intensity is sufficient or insufficient. Therefore, there is a need to design a smart window, or an intelligent, multifunction ambient light adjustment apparatus to overcome the above mentioned shortcomings.

## SUMMARY

One of exemplary embodiments comprises an ambient light adjustment (hereon called ALA) apparatus. The ALA apparatus comprises a main body having a plurality of edges, at least one light source, a light blocking layer and a controller. In the ALA apparatus, the light source is mounted on at least one of the plurality of edges of the main body. The light blocking layer is disposed over a surface of the main body. The controller is coupled to the light source and the light blocking layer. The controller controls light characteristics, e.g. intensity, wavelength, polarization and/or colour temperature of the light source and/or light blockage levels of the light blocking layer to achieve the goals of ambient light adjustment.

In one of exemplary embodiments, a system for adjusting indoor ambient light characteristics is proposed. The system comprises at least one indoor ALA apparatus. The ALA apparatus mentioned above further comprises at least one light guide plate. The controller can be set with at least one pre-set program, and the controller adjusts the light characteristics of the light source and/or light blockage levels of the light blocking layer based on the pre-set program, thereby the indoor ambient light characteristics are adjusted accordingly.

In one of exemplary embodiments, a method for an ALA apparatus to adjust indoor ambient light characteristics is proposed. The method of operating the ALA apparatus as mentioned above comprises following steps: sensing indoor light characteristics; comparing the sensed indoor light characteristics with a pre-set threshold; and adjusting the indoor ambient light characteristics based on the at least one pre-set threshold. The last step further comprises at least one of the following steps: adjusting a degree of blockage of the light blocking layer; adjusting light characteristics of the light source; and/or adjusting light characteristics of an indoor light source.

In one of exemplary embodiments, a method for fabricating an ALA apparatus mentioned above is also proposed. It comprises following steps: preparing a main body having a plurality of edges with at least one light guide plate;

2

disposing a light blocking layer on a surface of the light guide plate; attaching at least one light source element along at least one edge of the light guide plate; installing a controller and coupling it to the light source element and the light blocking layer.

More exemplary embodiments accompanied with figures are described in detail below in the disclosure.

## BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide further understanding, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments and, together with the description, serve to explain the principles of the disclosure.

FIG. 1A schematically illustrates an ALA apparatus in one of exemplary embodiments.

FIG. 1B schematically illustrates a decodable light blocking layer for a light blocking layer by programming spaces, frequencies and degrees of light blockage in one of exemplary embodiments.

FIG. 2 schematically illustrates an ALA apparatus in another one of exemplary embodiments.

FIG. 3 schematically illustrates an ALA apparatus in another one of exemplary embodiments.

FIG. 4A-FIG. 4D schematically illustrate different pre-set patterns for the light blocking layer in aforesaid embodiments or in one or some of exemplary embodiments of the disclosure.

FIG. 5 illustrates a circuit schematic for driving and decoding four pixels in the light blocking layer in the embodiments depicted in FIG. 4A through FIG. 4D.

FIG. 6 illustrates a flow diagram indicating a method for an ALA apparatus to adjust indoor ambient light characteristics in one of exemplary embodiments.

FIG. 7A and FIG. 7B schematically illustrate ALA apparatus in exemplary embodiments with light blocking layers comprising electro-chromatic layers.

FIG. 8 schematically illustrates a control architecture between a controller and a light blocking layer comprising electro-chromatic layers in an ALA apparatus of one of exemplary embodiments of the disclosure.

FIG. 9A and FIG. 9B schematically illustrate control architectures for a controller in an ALA apparatus of one of exemplary embodiments of the disclosure.

FIG. 10 schematically illustrates a blocking view example by using in an ALA apparatus of one of exemplary embodiments of the disclosure.

FIG. 11 schematically illustrates a calculation of signal/noise (S/N) ratio in an ALA apparatus of one of exemplary embodiments of the disclosure.

FIG. 12A through FIG. 12D schematically illustrate various modes that an ALA apparatus being served in one of exemplary embodiments of the disclosure.

FIG. 13A and FIG. 13B schematically illustrate an use of decodable light and an use of both decodable light and light blocking layer in the ALA apparatus depicted in FIG. 12D, respectively.

FIG. 14 schematically illustrates a blocking view example with a spatial multiplexed manner by using one mask in an ALA apparatus of one of exemplary embodiments of the disclosure.

FIG. 15 schematically illustrates a blocking view example with a time multiplexed manner by using two masks in an ALA apparatus of one of exemplary embodiments of the disclosure.

FIG. 16, FIG. 17A, FIG. 17B and FIG. 18 schematically illustrate a plurality of methods of adjusting an refractive index of a light guide plate in an ALA apparatus of one of exemplary embodiments of the disclosure.

#### DETAILED DESCRIPTION

The disclosure generally relates to an apparatus, a method or a system of adjusting ambient light. In one of exemplary embodiments, a smart window with ALA capability is disclosed.

In one of exemplary embodiments, the ALA apparatus comprises a main body having a plurality of edges, at least one light source, a light blocking layer and a controller. In the ALA apparatus, the light source is mounted on at least one of the plurality of edges of the main body. The main body comprises at least one light guide plate. The light blocking layer is disposed over the first surface of the main body. The controller is coupled to the light source and the light blocking layer. The controller controls light characteristics of the light source and/or light blockage levels of the light blocking layer to adjust ambient light characteristics. The aforesaid light characteristics comprise light intensity, light wavelength, light polarization and/or light colour temperature. The ALA apparatus further comprises at least one or more sensors coupled to the controller. The controller is configured to control the light characteristics of the light source and/or the light blockage levels of the light blocking layer according to a sensed result by the sensor or sensors.

In one of exemplary embodiments, a system for adjusting indoor ambient light characteristics is proposed. The system comprises an indoor ALA apparatus. The ALA apparatus comprises a main body having a plurality of edges, one or more light blocking layer, one or more light sources, and a controller. The main body further comprises at least one light guide plate. The controller is programmed with at least one pre-set threshold, and the controller adjusts light characteristics of the light source and/or light blockage levels of the light blocking layer based on the pre-set threshold, thereby the indoor ambient light characteristics are adjusted accordingly. The aforesaid light characteristics comprise light intensity, light wavelength, light polarization and/or light colour temperature.

For privacy and security purposes, a variety of proposals have been introduced, which are intended to avoid outsiders to peek inside a house through the smart windows. Traditionally, the privacy of the house is kept through installing shutters, curtains, blinds and/or other window blocking devices. One disadvantage is that people inside the house is also hard to see through the window when it is blocked. In one embodiment, an indoor ALA apparatus is proposed herein, in which at least within a certain view angle, the ALA apparatus can partially or entirely prevent an outsider to see through.

In another embodiment, a light blocking layer is introduced in the ALA apparatus or in the system, in which the light blocking layer is made decodable, so that it can block the view with different degrees of blockage. In one or some of exemplary embodiments of the disclosure, the light blocking layer can be manually or automatically adjusted through the controller or a remote control.

In one or some of exemplary embodiments of the disclosure, the light blocking layer can be programmed for displaying a pre-set pattern.

In the same embodiment or in other embodiment, light characteristics of a light source attached to the ALA appa-

ratus or the ALA apparatus in the system may be adjusted for blocking the view between the indoor position and the outdoor position.

In one embodiment of the ALA system, one or more programs stored in a memory unit are configured to be executed by the controller for performing sensing indoor light characteristics; comparing the sensed indoor light characteristics with a pre-set threshold; adjusting indoor light characteristics based on the comparison; and further conducting at least one of following steps: tuning the blockage of the light blocking layer; adjusting the light characteristics of the light source; and/or adjusting indoor light characteristics.

In one of exemplary embodiments, an operating method for an ALA apparatus to adjust indoor ambient light characteristics is proposed. The method comprises following steps: sensing indoor light characteristics; comparing the sensed indoor light characteristics with a pre-set threshold; and adjusting the indoor ambient light characteristics based on the at least one pre-set threshold by performing at least one of the following steps: adjusting a degree of blockage of the light blocking layer partially or entirely; adjusting light characteristics of the light source; and/or adjusting light characteristics of an indoor light source.

In one of exemplary embodiments, a method for fabricating an ALA apparatus is proposed. The method comprises following steps: preparing a main body having a plurality of edges with a light guide plate; disposing a light blocking layer on a surface of the light guide plate; attaching at least one light source element along at least one edge of the light guide plate; installing a controller which is coupled to the at least one light source element and the light blocking layer.

In one of exemplary embodiments of the method for fabricating the ALA apparatus, the light blocking layer is a prefabricated light blocking layer which is attached to the light guide plate. In one of exemplary embodiments of the method for fabricating the ALA apparatus, the light blocking layer is fabricated sequentially by: forming a first transparent conductive electrode; forming an electro-chromatic stack layer on the first transparent conductive electrode; and forming a second transparent conductive electrode on the surface of electro-chromatic stack layer. In one of exemplary embodiments of the method for fabricating the ALA apparatus, a diffusion layer is formed on a surface of the light guide plate.

Reference will now be made in detail to some embodiments of the disclosure, examples of which are illustrated in the accompanying drawings, but not limited thereto. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or like parts.

Please refer to FIG. 1A, which schematically illustrates an ALA apparatus in one of exemplary embodiments. The ALA apparatus 100 comprises at least a main body 110 (Dash-box), a light blocking layer 130, a plurality of light sources 160 (at least one left light sources 160L and/or one right light source 160R on the edge of the main body 110, for example) and a controller 170. The main body 110 has a plurality of edges 111. The plurality of light sources, for example, the light sources 160L and/or 160R are respectively mounted on at least one of the plurality of edges (such as 111L and 111R depicted in FIG. 1A) of the main body 110. The light blocking layer 130 is disposed over or on a top surface 184 of the main body 110 (dash box, as shown). The controller 170 is coupled to the light blocking layer 130 and the light sources 160L and/or 160R. The controller 170 controls light characteristics of the light sources 160L, 160R and degrees

of light blockage of the light blocking layer **130** to adjust ambient light characteristics. In the embodiment, the main body **110** may be a transparent substrate (such as a polymer substrate). The surface of the main body may be patterned so as to guide and adjust the light from the light sources **160**. The surface patterning methods may include thermal pressing, imprinting, laser or surface plasmon resonance (SPR). For example, in the surface plasmon resonance process, nanoparticles including Silver (Ag), Gold (Au) and Copper (Cu) may be firstly embedded in the polymer substrate via a physical or chemical manner, in which the aforementioned metal nano-particles may have various absorption bands, for example, Silver has the absorption band of 400 nm-450 nm, Gold has the absorption band of 500 nm-550 nm and Cooper has the absorption band of 580 nm-650 nm. Then, a laser beam is selected to irradiate on the polymer substrate embedded with metal nano-particles, such that the metal nano-particles absorbed heat from laser beam and locally melt away the surface of the polymer substrate. Afterwards, the remaining nanoparticles are removed which results in the polymer substrate with a roughened surface. Alternatively, even smaller nanoparticles may be employed and which are deformed after being irradiated by laser. As such, the nanoparticles are remained on the surface of the polymer substrate to create a polymer substrate with a roughened surface. In other words, a rough surface of the substrate, may be obtained through the two examples mentioned above, which improves the efficiency of light guidance.

In one of exemplary embodiments, the main body **110** comprises a light guide plate **114**. The material of the light guide plate comprises acrylic resin, polycarbonate, epoxy, glass, polyolefin (polyester, PMMA, PET, PP, PE), cyclo olefin polymer (COP), polycarbonate (PC), ABS, Epoxy, polyester, polysulfone, cellulose triacetate, polycarbonate, polyimide, polystyrene, or polymethylpentene. The light guide plate **114** may also be made of other transparent materials, for example, a light transmissive material (such as a transparent resin or a transparent glass). The light guide plate **114** may also be made of, for example, polyethylene, polypropylene, cyclo olefin polymer, polystyrene, polyacrylonitrile, polymethyl methacrylate, polyamide, polycarbonate, polyethylene terephthalate, polybutylene terephthalate, polyethylene naphthalene, or triacetyl cellulose, bisphenol fluorene derivatives or combination thereof, which may be used for the transparent plate. Besides, the light guide plate **114** may also be doped with inorganic particles or metal particles such as SiO<sub>2</sub>, SiO, TiO<sub>2</sub>, ZrO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, ZnS, Si<sub>3</sub>N<sub>4</sub>, MgF<sub>2</sub>, which the content of the afore-described particles may be within 30 wt % in the polymer substance, for instance.

In another embodiment, the light guide plate **114** may be embedded with high refractive index particles such as SiO<sub>2</sub>, SiO, TiO<sub>2</sub>, ZrO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, ZnS, Si<sub>3</sub>N<sub>4</sub> or MgF<sub>2</sub>, so as to have a desired refractive index for the light guide plate **114**. For example, the refractive index values of the light guide plate **114** may be distributed in a ladder manner. Specifically, the particles with various refractive indexes are added during multi-stage (or at least two-stage) polymerization to form such light guide plate **114**. The solid content concentration of these particles is varied along a thickness direction of the light guide plate **114**, so as to result in a ladder (or gradient) variation of the refractive index values of the light guide plate **114**.

Generally, two kinds of diffusion layer are disclosed here. One is to embed such layer inside or on the surface of the light guide material, the other one is to form or coat a diffusion layer with a specific refractive index on the surface

of the light guide plate. Therefore, in this disclosure, either way can be used. Details of these method and material are described in the following sessions.

In one embodiment, a first surface **182** of the light guide plate **114** may be modified for example imprinted with light diffusible particles to have a desired refractive index. The refractive index of light guide plate **114** may be in a range from about 1.2 to about 2.5. The size of the diffusible particles is in a range from about 0.01  $\mu$ m to about 10  $\mu$ m. The materials of light diffusible particles are selected from the group consisting of SiO<sub>2</sub>, SiO, TiO<sub>2</sub>, ZrO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, ZnS, Si<sub>3</sub>N<sub>4</sub>, MgF<sub>2</sub>, or combination thereof.

In one embodiment, the main body **110** further comprises at least one diffusion layer **112** formed on the first surface **182** of the light guide plate **114**. The diffusion layer **112** can be a self-assembled monolayer, a particle-embedded layer, a micro-machined structure layer or a printed dot-pattern layer, for example. For example, the self-assembled monolayer (SAM) is organic molecules which are molecular assembly formed spontaneously on surfaces by adsorption and are organized into more or less large ordered domains.

A self-assembly monolayer may be formed on a base material (the first surface **182** of the light guide plate **114**). The self-assembly monolayer may be bonded with the modified particles. The self-assembly monolayer may also be formed on a bonding layer. A material for the self-assembly monolayer may have a head group and functional-end group. In such material, the head group may be connected to an alkyl chain, in which another end of the head group without connecting to the alkyl chain may be functionalised (that is, adding the groups of —OH, —NH<sub>2</sub> or —COOH), such that the wetness and the interfacial properties of the self-assembly monolayer may be varied. The functional-end group may be selected from —OH, —CHO, —COOH, —SH and —CONH<sub>2</sub>, although the disclosure is not limited thereto. The type of the head and end group depends on the usage of the self-assembly monolayer. A surface that the head and end group may be attached including a surface of a silicon wafer, a metal layer or a curved surface (for instance, a surface of a nano-particle). The material for the self-assembly monolayer may include alkanethiols, disulfides, dialkyl disulfides, dialkyl sulfides, alkylxanthates or dialkylthiocarbamates. The alkanethiol may be a molecule which has the alkyl chains serving as the skeleton, a terminal group (such as a S—H or O—H group) and a S—H head group. The alkanethiols may be applied to a noble metal substrate, this is due to sulphur has strong affinity towards such metal. For example, the material of the self-assembly monolayer may include HS—C<sub>n</sub>H<sub>2n</sub>—COOH (such as, HS—C<sub>3</sub>H<sub>6</sub>—COOH), HS(CH<sub>2</sub>)<sub>16</sub>OH, HS(CH<sub>2</sub>)<sub>15</sub>CO<sub>2</sub>CH<sub>3</sub>, HS(CH<sub>2</sub>)<sub>15</sub>CH<sub>3</sub>, HS(CH<sub>2</sub>)<sub>15</sub>COOH, HS(CH<sub>2</sub>)<sub>16</sub>SO<sub>4</sub>H, HS(CH<sub>2</sub>)<sub>9</sub>CH<sub>3</sub>, NH<sub>2</sub>(CH<sub>2</sub>)<sub>n</sub>SH, HS(CH<sub>2</sub>)<sub>11</sub>CONH<sub>2</sub> or Si(OCH<sub>3</sub>)<sub>3</sub>—(CH<sub>2</sub>)<sub>n</sub>SH. The S—H head end group in the material forms covalent bonds with the modified particles, such that the particles are secured on the first surface **182** of the light guide plate **114** to form the diffusion layer **112**. On the other hand, the particles may be distributed across the first surface **182** of the light guide plate **114** through selecting various self-assembly materials to form a patterned diffusion layer **112**, in order to control the position of the light being emitted.

In the embodiment, when the diffusion layer **112** has been fabricated as described above (namely, the self-assembly monolayer being patterned), a protective layer **150B** may be disposed on the surface of the diffusion layer **112** so as to protect the diffusion layer **112**. With the use of the diffusion layer **112** in the ALA apparatus **100**, the light can be

prevented to be emitted out from the diffusion layer **112** side while transmitting in the light guide plate **114**. In other words, a majority of light are emitted from the light blocking layer **130** side, so as to enhance the light utilization efficiency of the ALA apparatus **100**.

In one embodiment, the light blocking layer **130** may be a decodable light blocking layer **130** for programming spaces, frequencies and degrees of light blockage. That means that a pre-determined or pre-set pattern may be arranged by decoding in the light blocking layer **130**, in which different areas or partitions thereof may have different degrees of light blockage. The light blocking layer **130** can comprise electro-chromatic layers or electro-wetting layers. In one embodiment, the light blocking layer **130** comprises a transparent conductive electrode, an electro-chromatic stack layer on the first transparent conductive electrode, and a second transparent conductive electrode on the electro-chromatic stack layer. The electro-chromatic stack layer comprises an electro-chromic (EC) layer, an ion conductor (IC) layer on the electro-chromic (EC) layer, and a counter electrode (CE) layer on the ion conductor (IC) layer. Detailed description of the structure of the light blocking layer is shown in FIGS. **7A** and **7B**.

In one embodiment, the light source **160L** or the light source **160R** may be an light emitting diode (LED) device, an electroluminescent (EL) light device, a light bulb, and a cold-cathode fluorescent lamp (CCFL). The light source **160L** or the light source **160R** may also be a multiple spectrum light source or a full-spectrum light. The full-spectrum light is a light that covers the electromagnetic spectrum from infrared to near-ultraviolet, or all wavelengths that are useful to plant or animal life.

In one of exemplary embodiments, the ALA apparatus **100** further comprises a protective layer **150A** on a surface of the light blocking layer **130** opposing to another surface of the light blocking layer **130** facing the top surface **184** of the main body **110** (dash box, as shown). In other embodiment, the ALA apparatus **100** may further comprise another protective layer **150B** on a bottom surface **180** of the main body **110** (dash box, as shown). The protective layer **150A** or **150B** may comprise materials of transparent organic, inorganic, hybrid materials, or a combination thereof. The transparency of the protective layer **150A** or **150B** is preferably to be greater than about 80%. The protective layer may be composed of organic material, inorganic material or hybrid material. The organic material for the protective layer may include polyolefin (polyester, PMMA, PET, PP, PE), cyclo olefin polymer (COP), polycarbonate (PC), ABS, epoxy, polyester, polysulfone, cellulose triacetate, polycarbonate, polyimide, polystyrene, or polymethylpentene. The hybrid material for the protective layer may be hard-coated, so that the protective layer may be a monolayer or multi-layers.

When the protective layer is composed of a monolayer, such polymer layer is served as a matrix doped with an anti-UV agent (which can be categorized into physical absorption and reflection types, for instance), and a scratch-endurable antisolvent may be added into the matrix regarding hardness improvement, such as adding SiO<sub>2</sub>, TiO<sub>2</sub>, ZrO<sub>2</sub>, CNT or carbon nanoparticles, Al<sub>2</sub>O<sub>3</sub> and combination thereof. Besides, the design of the molecular structure of such polymer may also be employed, along with the use of scratch-endurable antisolvent, so as to improve the hardness of the protective layer. On the other hand, the vitex system may be referred when the protective layer is composed of multi-layers, in which one layer of the multi-layers may be an organic layer and another layer may be a stacked inor-

ganic layer. For example, the multi-layers of the disclosure may be constituted by at least one organic layer and one inorganic layer, although the disclosure is not limited thereto. With the use of protective layer, the ALA apparatus **100** may become more tolerable, UV-resistible (such as, an anti UV agent), waterproof, anti scratch and anti corrosion, thereby extending the lifespan of the ALA apparatus **100** and increasing the reliability thereof.

In one of exemplary embodiments, the ALA apparatus **100** further comprises at least one **172** or more sensors **172** and **174** coupled to the controller **170**. The controller **170** controlling the light characteristics of the light source and/or the light blockage levels of the light blocking layer **130** according to a sensed result by the sensor or sensors. For example, a sensor **172** may be disposed adjacent to the protective layer **150A** facing a direction to an outdoor position **102**, as shown in FIG. **1A**. The sensor **172** may sense outdoor light characteristics and send the measured result therefrom to the controller **170**. In other embodiment, the ALA apparatus **100** may further comprise another sensor **174** disposed adjacent to the protective layer **150B** facing a direction to an indoor position **104**. The sensor **174** may sense indoor light characteristics and send the measured result therefrom to the controller **170**. The aforesaid light characteristics comprise light intensity, light wavelength, light polarization and/or light colour temperature. The sensor **172** and/or **174** may comprise a plurality of multiple spectrum sensing units, which may sense lights characteristics comprise light intensity, light wavelength, light polarization and/or light colour temperature with multiple spectrums. Optionally, the sensor **172** or **174** may be integrated into the controller **170**.

Please refer to FIG. **1B** for illustrating a decodable light blocking layer for a light blocking layer by programming the spaces, frequencies, and degrees of light blockage. The pre-determined or pre-set pattern **190C** may be arranged by decoding in the light blocking layer **130**, in which different areas or partitions thereof may have different spaces, frequencies and degrees of light blockage. The light **190A**, no matter from the indoor position to the outdoor position or from the outdoor position to the indoor position, can be fully or partially blocked as desired, and the light **190A** passing through the light blocking layer **130** is changed to the light **190B** with the light characteristics with the pre-determined or pre-set pattern **190C**.

Please refer to FIG. **2**, which schematically illustrates an ALA apparatus in another one of exemplary embodiments. The ALA apparatus **200** comprises a main body **210** sandwiched in between two light blocking layers (**230A** and **230B**), light sources (**260L** and **260R**) and controller (**270**). The two light blocking layers can be independently programmed to partially or entirely block the view between an indoor position and an outdoor position. In one or some of exemplary embodiments, either or both of the two light blocking layers is/are manually or automatically adjusted independently or correlated with each other through the controller, or a remote control **271**. In one or some of exemplary embodiments of the disclosure, the light blocking layer can be programmed to be adjusted the light blockage levels for displaying a pre-set pattern. The two light blocking layers may be programmed according to the same or different pre-set pattern(s), or to have the same or different spaces, frequencies and degrees of light blockage. For more details, the ALA apparatus **200** comprises at least a main body **210** (dash box, as shown), two light blocking layers **230A** and **230B**, one or more light sources **260** (**260L** and **260R**) and a controller **270**. The ALA apparatus **200** further

comprises a protective layer **250A** disposed on the surface of light blocking layer **230A** and another protective layer **250B** disposed on the surface of the light blocking layer **230B**. In one of exemplary embodiments, the ALA apparatus **200** further comprises two sensors **272** and **274** respectively disposed over the light blocking layer **230A** facing an outdoor position **202** and the blocking layer **230B** facing an indoor position **204**. The two sensors **272** and **274**, coupled to the controller **270**, for sensing light characteristics respectively in an outdoor environment and in an indoor environment and send the measured results therefrom to the controller **270**. The aforesaid light characteristics comprise light intensity, light wavelength, light polarization and/or light colour temperature.

It is understandable that a remote control can also be provided for user convenience to perform similar functions as those of the system controller mounted on the ALA apparatus. In this case, the ALA apparatus must be installed with a receiver to receive commands from the remote control and transmit the commands to the system controller mounted on the ALA apparatus. Such a remote control may comprise: (1) a power supply means, such as battery or battery set, for supplying power to the remote control; (2) a keyboard for inputting ALA apparatus control commands and setting parameters, such as thresholds, temperature, time, date, etc.; (3) a micro-control chip coupled to the keyboard and the power supply means for accepting the ALA apparatus control commands from the user; (4) a transmitter means coupled to said control means and said power supply means for transmitting the control signals to the ALA apparatus; and optionally; and (5) an animated ALA apparatus display coupled to the control means for displaying an animated pictorial representation of the ALA apparatus status.

The main body **210** has a plurality of edges (**211L** and **211R**). The light sources **260L** and **260R** are respectively mounted on the edges **211L** and **211R** of the main body **210**. The light blocking layer **230A** is disposed over or on a first surface **280** of the main body **210**, and the other light blocking layer **230B** is disposed over or on a second surface **282** of the main body **210**. The controller **270** is coupled to the light blocking layers **230A**, **230B** and the light sources **260L** and **260R**. The controller **270** controls light characteristics of the light sources **260L** and **260R** and/or light blockage levels of the light blocking layers **230A** and **230B** to adjust ambient light characteristics.

In one of exemplary embodiments, the main body **210** comprises a light guide plate **216**. The light guide plate **216** is made of transparent material comprises acrylic resin, polycarbonate, epoxy, or glass, etc. which has been described in a previous session.

In one embodiment, the light guide plate **216** may be formed by using a similar material and technique as the light guide plate described in FIG. 1A and thus will not be repeated here.

In one embodiment, the light blocking layer **230A** and/or **230B** may comprise electro-chromatic layers or electro-wetting layers. In one embodiment, the light blocking layer **230A** or **230B** comprises a similar structure and decoding scheme as those of light blocking layer shown in FIG. 1A and thus will not be further described.

Please refer to FIG. 3, which schematically illustrates an ALA apparatus in another one of exemplary embodiments. With the similar structure of FIG. 1A, the ALA apparatus **300** comprises two main bodies stacked together and a light blocking layer sandwiched in between these two main bodies. Two edges of each main body are respectively

attached with one set of light source. Each of the two main bodies may further comprise a light guide plate and/or a diffusion layer. A controller, coupled to these light sources and the light block layer, is also provided to control light characteristics of the light sources and/or light blockage levels of the light blocking layer to adjust ambient light characteristics.

The light blocking layer is partially or entirely adjusted with the light blockage level for blocking the view between an indoor position and an outdoor position. In one or some of exemplary embodiments, the light blocking layer is manually or automatically adjusted independently or correlated with each other through the controller. In one or some of exemplary embodiments of the disclosure, the light blocking layer can be programmed to be adjusted the light blockage levels for displaying a pre-set pattern. The light blocking layer **330** may be programmed to a pre-set pattern or to have certain spaces, frequencies and degrees of light blockage.

For more details, the ALA apparatus **300** comprises at least a first main body **310** (dash box, as shown), a second main body **320** (dash box, as shown), a light blocking layer **330**, light sources **360L**, **360R**, **362L**, **362R** and a controller **370**. The light blocking layer **330** is sandwiched in between the first main body **310** and the second main body **320**. The ALA apparatus **300** further comprises a protective layer **350A** which is disposed on a surface **386** of the second main body **320** facing to an outdoor position **302**. The ALA apparatus **300** further comprises a second protective layer **350B** on a surface **382** of the first main body **310** facing to an indoor position **304**. In one of exemplary embodiments, the ALA apparatus **300** further comprises two sensors **372** and **374** respectively disposed adjacent to the second main body **320** facing the outdoor position **302**, and the first main body **310** facing the indoor position **304**. The two sensors **372** and **374**, coupled to the controller **370**, will sense light characteristics respectively in an outdoor environment and in an indoor environment and send the measured results therefrom to the controller **370**. The aforesaid light characteristics comprise light intensity, light wavelength, light polarization and/or light colour temperature.

Each of the first main body **310** and the second main body **320** has a plurality of edges (**311L** and **311R**, **321L** and **321R**). The light sources **360L** and **360R** are respectively mounted on the edges **311L** and **311R** of the first main body **310**. The light sources **362L** and **362R** are respectively mounted on the edges **321L** and **321R** of the second main body **320**.

The controller **370** is coupled to the light blocking layer **330** and the light source **360L**, **360R**, **362L**, **362R** and the light blocking layer **330**. The controller **370** controls light characteristics of the light sources **360L**, **360R**, **362L**, **362R** and/or light blockage level of the light blocking layer **330** to adjust ambient light characteristics.

In one of exemplary embodiments, the first main body **310** comprises a light guide plate **314**, and the second main body **320** comprises another light guide plate **324**. The material of each of the light guide plates **314** and **324** are made with a similar material as those mentioned in FIG. 1A and FIG. 2, and thus will not be repeated here.

In one embodiment, the light guide plate **314** or **324** may be embedded or imprinted with light diffusible particles as mentioned earlier, and will not further described.

In other embodiment, the first main body **310** or the second main body **320** may further comprise at least a diffusion layer. For example, a diffusion layer **312** is formed on a first surface **384** of the light guide plate **314** and a



## 11

diffusion layer **322** is formed on a first surface **388** of the light guide plate **324**. Such diffusion layer has also been described in a previous session.

In one embodiment, the light blocking layer **330** may comprise electro-chromatic layers or electro-wetting layers. In one embodiment, the light blocking layer **330** comprises a transparent conductive electrode, an electro-chromatic stack layer on the first transparent conductive electrode, and a second transparent conductive electrode on the electro-chromatic stack layer.

The main goal of the dual light guide window design is to allow the window to selectively and independently emit the light towards either indoor or outdoor direction by using its own light source. It is not only applicable for adjusting ambient light, but also for displaying a pre-set pattern.

It is understandable, if the light guide material used already has embedded diffusion layer, the extra diffusion layer **312** and **322** can be omitted.

Please refer to FIG. 4A-FIG. 4D, which schematically illustrate different pre-set patterns for the light blocking layer in aforesaid embodiments or in one or some of exemplary embodiments of the disclosure. The light blocking layer introduced in the ALA apparatus or in the system, is partially or entirely adjusted with the light blockage levels for blocking the view between an indoor position and an outdoor position. The light blocking layer is manually or automatically adjusted through a controller. The light blocking layer can be made with decodable pixel array arrangement, so it can be programmed to display any pre-set patterns. It can also be programmed to switch at least one pixel or pixel groups on/off on selected address, for example, the pre-set patterns **510**, **520**, **530** and **540** respectively depicted in FIGS. 4A, 4B, 4C and 4D. It is also possible to partially switch at least one pixel or pixel groups to a preset blockage level. For example, as shown in FIG. 4A, there are at least two kinds of areas **511** and **512** with different light blockage levels, which are arranged to form the pattern **510**. For instance, ignoring absorption of materials, the light blockage level of area **511** may be 75% of transmittance and 25% of reflectance. The light blockage level of area **512** may be 100% of transmittance and 0% of reflectance (ignore absorption) in FIG. 4A. As in FIG. 4B, there are at least three kinds of areas **521**, **522** and **523** with different light blockage levels, which are arranged to form the pattern **520**. For instance, the light blockage level of area **521** may be 75% of transmittance and 25% of reflectance (ignore absorption). The light blockage level of area **522** may be 100% of transmittance and 0% of reflectance (ignore absorption). The light blockage level of area **523** may be 50% of transmittance and 50% of reflectance (ignore absorption) in FIG. 4B. As in FIG. 4C, there are at least four kinds of areas **531**, **532**, **533** and **534** with different light blockage levels, which are arranged to form the pattern **530**. For instance, the light blockage level of area **531** may be 75% of transmittance and 25% of reflectance (ignore absorption). The light blockage level of area **532** may be 50% of transmittance and 50% of reflectance (ignore absorption). The light blockage level of area **533** may be 100% of transmittance and 0% of reflectance (ignore absorption). The light blockage level of area **534** may be 25% of transmittance and 75% of reflectance (ignore absorption) in FIG. 4C. As in FIG. 4D, there are at least four kinds of areas with different light blockage levels, which are arranged to form the pattern **540**, similar as the areas depicted in FIG. 4C. The difference between the areas depicted in FIG. 4C and FIG. 4D is that the light is blocked in one kind of the areas in FIG. 4D instead of being transmissive as the area **533** in FIG. 4C.

## 12

The different patterns may be selectively chosen by using one or more light blocking layers in an ALA apparatus of exemplary embodiments. In other words, the blocking layer may be achieved the afore-described patterns through utilizing the electro-chromatic layers or the electro-wetting layers, so as to adjust a level of blockage of the light blocking layer partially or entirely.

FIG. 5 illustrates a circuit schematic for driving and decoding four pixels in the light blocking layer in the embodiments depicted in FIG. 4A through FIG. 4D. Referring to FIG. 5, the circuit schematic **550** includes a row driver **551**, a column driver **552** and a plurality of cells respectively arranged in array. Each cell represents as the pixel of the pre-set patterns described above. For instance, the cells **C1**, **C2**, **C3**, **C4** depicted in FIG. 5 may be considered as the pixel areas **531**, **532**, **533**, **534** depicted in FIG. 4C, respectively.

Each cell includes a switch and a cell component, in which the switch is electronically connected to a bit line, i.e. **B00**, **B01** and a word line, i.e. **W00**, **W01** and the cell component is coupled to the switch. Further, the word lines and the bit lines are respectively connected to the row driver **551** and the column driver **552**. For instance, the cell **C1** includes a switch **S1** and a cell component **Cell00**, in which the switch **S1** is electronically connected to a bit line **BL00** and a word line **WL00**, and the cell component **Cell00** is coupled of the switch **S1**. The bit line **BL00** is connected to the column driver **552**, while the word line **WL00** is connected to the row driver **551**.

Under the configuration of the embodiment, each switch of the cell component on the light blocking layer is enabled through the row driver **551** or the column driver **552**, so as to drive the cell component to control the light blockage level of the cell. In other words, each cell may be independently controlled, and the cells are programmed to form a desired pattern such as the pre-set patterns **510**, **520**, **530** and **540** depicted in FIGS. 5A, 5B, 5C and 5D. By this way, the light blocking layer can be programmed to be adjusted the light blockage levels, or for displaying the pre-set pattern.

Please refer to FIG. 6, a flow diagram which illustrates a method for an ALA apparatus to adjust indoor ambient light characteristics in one of exemplary embodiments. In the method for the ALA apparatus, indoor light characteristics are sensed firstly. The sensed indoor light characteristics are compared with a pre-set threshold. The indoor ambient light characteristics are adjusted based on the at least one pre-set threshold by performing at least one of the following steps: adjusting a degree of blockage of the light blocking layer partially or entirely; adjusting light characteristics of the light source; and adjusting light characteristics of an indoor light source. There are of course many ways to set the program, here a more energy-saving route is considered. Any other method similar to this approach is not excluded from the spirit of this proposal.

For more details, please refer to FIG. 6, in step **S602**, the method starts from sensing the indoor light characteristics, for example, an interior light intensity of the indoor light characteristics is sensed and obtained a set of measured results therefrom, which is denoted as "I" in FIG. 6. The aforesaid light characteristics may comprise, but not limited thereto, a light intensity, a light wavelength, a light polarization and/or a light colours temperature, or combination thereof. In step **S604**, the interior light intensity (I) is compared with a pre-set threshold level, denoted as "T", which is prepared in advance or is designated by the user. If the interior light intensity (I) is smaller than the pre-set threshold level (T), light blocking degree ("B") or the light

13

blockage level of a light blocking layer in the ALA apparatus will be reduced to increase the interior light intensity (I) of the indoor light characteristics, as in step S610. In step S612, it is then determined that if the light blocking degree (B) is reduced to zero. If no, it means that there still is room to change the light blocking degree (B) and then the step of comparing the interior light intensity (I) with the pre-set threshold level will be processed again, as in step S618. If the interior light intensity (I) is still smaller than the pre-set threshold level (T), the step S610 will be performed in an iterative manner till there is no room to increase the interior light intensity (I) by adjust the light blocking degree (B).

If the comparing result in step S612 is yes, it means that the light blocking degree (B) cannot be reduced anymore to improve or increase the interior light intensity (I), as in step S614, light emitting degrees of light sources in the ALA apparatus may be increased. As in some of the aforesaid embodiments, for example, two light sources are proposed and their light emitting degrees (E1/E2) are increased to provide more lights to improve or increase the interior light intensity (I). As in following step S616, the step of comparing the interior light intensity (I) with the pre-set threshold level will be processed again. In this case, if the interior light intensity (I) is still smaller than the pre-set threshold level (T), the step S614 will be performed again in an iterative manner till the interior light intensity (I) is greater than the pre-set threshold level (T).

In other case, in step S604, that the interior light intensity (I) is not smaller than the pre-set threshold level (T), light emitting degrees of light sources in the ALA apparatus may be decreased. For example, two light sources are proposed and their light emitting degrees (E1/E2) are decreased to provide lower or fewer lights to decrease the interior light intensity (I), in step S620. In step S622, it is then determined that if the light emitting degrees (E1/E2) of the light sources are reduced to zero. If no, it means that there still is room to change the light emitting degrees (E1/E2) and then the step of comparing the interior light intensity (I) with the pre-set threshold level will be processed again, as in step S628. If the interior light intensity (I) is still larger than the pre-set threshold level (T), the step S620 will be performed in an iterative manner till there is no room to decrease the interior light intensity (I) by adjust the light emitting degrees (E1/E2). If the comparing result in step S622 is yes, it means that the light emitting degrees (E1/E2) cannot be reduced anymore to decrease the interior light intensity (I), as in step S624, the light blocking degree (B) or the light blockage level of the light blocking layer may be increased to blocking incident lights. As in following step S626, the step of comparing the interior light intensity (I) compared with the pre-set threshold level will be processed again. If the interior light intensity (I) is still larger than the pre-set threshold level (T), the step S624 will be performed again in an iterative manner till the interior light intensity (I) is smaller than the pre-set threshold level (T).

In another embodiment (not shown), instead of iteratively comparing the interior light intensity (I) with the pre-set threshold level (T) as shown in step 604 of FIG. 6, the pre-set threshold level (T) may be arranged as  $T_{min}/T_{max}$ , and when the interior light intensity (I) is greater than the pre-set threshold level (T) and the interior light intensity (I) is greater than  $T_{max}$  (namely,  $I > T$  and  $I > T_{max}$ ), the subsequent adjustment is then performed.

In other embodiment (not shown), the comparison between the interior light intensity (I) and the pre-set threshold level (T) may be an error value (E) so as to perform the step S604, that is, the interior light intensity (I) is an error

14

value (E) less than the pre-set threshold level (T),  $I < T + E$ , or the interior light intensity (I) is an error value (E) greater than the pre-set threshold level (T),  $I > T + E$ , where the error value (E) may be configured as 0%-10% of the pre-set threshold level (T).

Alternatively, the interior light intensity (I) may be arranged to be  $\pm 10\%$  tolerance of the pre-set threshold level (T), so that the method for the ALA apparatus to adjust indoor ambient light characteristics may be began automatically. Further, it should be noted that the comparison depicted in step S604 may not be required to compare all the time, such comparison may be performed periodically. For example, the step S602 may be performed automatically every half an hour, so that the adjustment of light emitting degrees (E1/E2) or light blocking degree (B) is executed every 30 minutes. The time for starting the step S602 may be arranged, for instance, the step S602 is set not to perform from 10 pm to 5 am every day, or the step S602 is set to perform at 6 am, 13 pm and 20 pm every day, although the disclosure is not limited thereto. A user may manually program the controller within a period of time for controller to learn user's preference of interior light settings. After, the manual mode period is over, the user can switch it to an automatic mode, the controller will take over and use the user's preference settings to control the indoor light characteristics.

Please refer to FIG. 7A, which schematically illustrates an ALA apparatus in one of exemplary embodiments with a light blocking layer comprising electro-chromatic layers. The ALA apparatus 700 comprises at least a main body 710, a light blocking layer 720, a plurality of light sources (730, for example) and a controller (not shown). The main body 710 may comprise a light guide plate and a diffusion layer 712. The diffusion layer can be fully or partially disposed on the surface of the light guide plate. In this particular example, the diffusion layer is partially coated on the light guide plate. Such that the light blocking layer 720 is disposed partially on the main body 710 or partially on the diffusion layer 712. The controller controls light characteristics of the light source 730 and/or light blockage levels of the light blocking layer 720 to adjust ambient light characteristics. The ALA apparatus 700 further comprises a protective layer 740 on the light blocking layer 720 and a protective layer 742 on the main body 710 opposing to the surface facing the light blocking layer 720.

In one embodiment, the light guide plate may be embedded or imprinted with light diffusible particles to have a desired refractive index. In another embodiment, the diffusion layer 712 may also be provided for the refractive index. The diffusion layer 712 can be a self-assembled monolayer, a particle-embedded layer, a micro-machined structure layer or a printed dot-pattern layer, for example.

In one embodiment, the light blocking layer 720 may be a decodable light blocking layer for programming spaces, frequencies and degrees of light blockage. That means that a pre-determined or pre-set pattern may be arranged by decoding in the light blocking layer 720, in which different areas or partitions thereof may have different degrees of light blockage. In the embodiment, the light blocking layer 720 can comprise electro-chromatic devices 722. In one embodiment, please refer to FIG. 7B, the electro-chromatic devices 722 comprises a transparent conductive layer (TCL) 7221A, an electro-chromatic stack layer on the first transparent conductive electrode, and a second transparent conductive layer (TCL) 7221B on the electro-chromatic stack layer. The electro-chromatic stack layer comprises an electro-chromic

15

(EC) layer **7222**, an electrolyte layer **7223** on the electrochromic (EC) layer **7222**, and an ion layer **7224** stacked together.

The electrochromic (EC) layer **7222** may comprise  $H_xWO_3$ ,  $LixWO_3$ ,  $NaxWO_3$ ,  $MoO_3$ ,  $V_2O_5$ ,  $Nb_2O_5$  or  $TiO_2$ , (4-((N,N-dimethylamine)-phenyl) (phenyl) amino benzyl) phosphoric acid, for example. The ion layer **7224** may comprise ion conductive materials, metal salts, alkali metal salts, alkaline earth metal salts, quaternary ammonium salts, alloy, metal oxide, ceramic oxide, modified-PMMA,  $Ta_2O_5$ ,  $SiO_2$ , Poly-AMPS, PEO copolymer,  $LiClO_4$ /Poly carbonat, Li-PEO,  $Li-B-SiO_2$ , PPG- $LiClO_4$ -MMA,  $LiNbO_3$ , Modified PEO, Li polymer, titanium dioxide (rutile), zirconium dioxide with yttrium oxide,  $LiAl_5O_8$ ,  $Li_5AlO_4$ ,  $LiMnO_2$ ,  $Li_2MnO_2$ ,  $LiCoO_2$ ,  $LiNiO_2$ ,  $LiFeO_2$ ,  $NaNiO_2$ ,  $NaCoO_2$  doped iron,  $AgNO_3$  with  $Ni(NO_3)_2$ ,  $Co(NO_3)_2$ , PEDOT. The electrolyte layer **7223** may comprise solvent type electrolyte such as the solvent such as propylene carbonate, ethylenecarbonate, sulfolane, gamma-butyrolactone, dimethylformamide, dimethylsulfoxide, ethylene carbonate, Polymer type electrolyte such as polyethylene oxide, polyoxyethylene glycol polymethacrylate. The ion storage layer may comprise  $NiO$ ,  $CeOx$ ,  $LixCrO_4$ ,  $LiV_2O_5$ ,  $LiCoO_2$ ,  $Li_xNi_yO$ ,  $V_2O_5$ ,  $Cr_2O_3$  or  $CoO$ .

Please refer to FIG. 8, which schematically illustrates a control architecture between a controller and a light blocking layer comprising electrochromatic layers in the ALA apparatus of one of exemplary embodiments of the disclosure. In the control architecture, the controller may, for example, comprises a micro controller **810** coupled to a plurality of window controllers each of which for controlling respective one of electrochromatic units. As shown, the window controller **820** is coupled to an electrochromatic unit (EC1) **840**, and the other window controller **830** is coupled to another electrochromatic unit (EC2) **850**. In this case, each window controller can control a portion of the window or a full window. The micro-controller may be used to control a smart window system comprises a plurality of windows.

Please refer to FIG. 9A and FIG. 9B, which schematically illustrate control architectures for a controller in an ALA apparatus of one of exemplary embodiments of the disclosure. The controller is programmed with at least one pre-set threshold, and the controller adjusts light characteristics of the light source and/or light blockage levels of the light blocking layer based on the pre-set threshold, thereby the indoor ambient light characteristics are adjusted accordingly. The aforesaid light characteristics comprise light intensity, light wavelength, light polarization and/or light color temperature.

In one embodiment, the controller comprises a micro controller **910**, which is coupled to a plurality of peripheral devices such as a light sensor **912**, a power source **914**, a temperature sensor **916**, an interface device **918**, a data extraction unit **920**, an input device **922** and a display **924**. The power source **914** provides power for the micro controller **910**. The light sensor **912** and the temperature sensor **916** respectively provide sensed results of light and temperature to the micro controller **910**. The interface device **918** provides an interface for connecting to external devices such as a Smart phone, a remote control, or any other handheld device. The display **924** provides an interface for displaying some information, or one may also use interface to link a remote display to monitor and control the operation.

As shown in FIG. 9B, the micro controller **910** is coupled to a plurality of input devices, i.e. **930**, **940** and **950**, such as a key board, voice activation device, microphone, touch

16

panel, etc. to input parameters or setting programs. Through the input device **930**, a light switching unit **932** and a light tuner is controlled by the micro controller **910**. Through the input device **940**, a transmission status unit **942**, a light sensor **944** and a temperature sensor **946** and an irregular alarm **948** are controlled by the micro controller **910**. Through input device **950**, a transmission status unit **952**, a light sensor **954** and a temperature sensor **956** and an irregular alarm **958** are controlled by the micro controller **910**.

In aforesaid embodiment, one or more programs stored in a memory unit are configured to be executed by the micro controller **910** for conducting sensing indoor light characteristics; comparing the sensed indoor light characteristics with a pre-set threshold; adjusting indoor light characteristics based on the comparison; and conducting at least one of following steps: tuning the blockage of the light blocking layer; adjusting the light characteristics of the light source; and adjusting indoor light characteristics.

Please refer to FIG. 10, which schematically illustrates a blocking view example by using in an ALA apparatus of one of exemplary embodiments of the disclosure. The indoor ALA apparatus **1020** with a micro controller **1010** is provided for adjusting indoor ambient light characteristics herein. By using the ALA apparatus **1020**, a view or a view angle between an indoor position **1002** and an outdoor position **1004** can be partially or entirely blocked. Two sensors **1030** and **1032** are further provided to the indoor ALA apparatus **1020**, so as to respectively sense the light characteristics of the indoor and outdoor environments.

In one of exemplary embodiments, a signal/noise (S/N) ratio modification method is proposed for adjusting the view or the view angle of the architecture. Moreover, in one embodiment, a light blocking layer is introduced in the ALA apparatus or in the system, in which the light blocking layer may be partially or entirely adjusted with the light blockage levels for blocking the view between the indoor position **1002** and the outdoor position **1004** manually or automatically via the controller **1010**.

Based on human vision principle, several factors are taken into consideration in the operation of the indoor ALA apparatus **1020**, that is, the signal/noise (S/N) ratio modification, the spatial frequency and the pupil diameter. Specifically, the pupil diameter of a human eye varies in response to the change of ambient light intensity, for instance, the pupil diameter shrinks as the ambient light intensity increases, while the pupil diameter enlarges as the ambient light intensity decreases. In other words, the diameter of the pupil generally depends on an average luminance of an observed object. As such, the pupil diameter for a given luminance may be calculated through the following formula:

$$d=5-3 \tan h(0.4 \log L) \quad (\text{Formula 1})$$

where L is the average luminance in units, d is the pupil diameter in mm.

Besides, when the field size is taken into account, the pupil diameter for a given luminance may be obtained through the following formula:

$$d=5-3 \tan h\{0.4 \log(LX_0^2/40^2)\} \quad (\text{Formula 2})$$

where  $X_0$  is the angular field size of the object in degrees. It should be noted that the calculation of the pupil diameter in the disclosure may be referred to "Contrast Sensitivity of the Human Eye and Its Effects on Image Quality—Peter G. J. Barten, 1999", and thus the detailed description of the pupil diameter calculation will be omitted hereafter.

17

In addition, after the pupil diameter is calculated through the afore-described formulas, an retinal illumination of the human eye may be further calculated through the following formula:

$$E_{(Troland)} = \frac{\pi d^2}{4} L \quad (\text{Formula 3})$$

$$E = \frac{\pi d^2}{4} L \left\{ 1 - \left( \frac{d}{9.7} \right)^2 + (d / 12.4)^4 \right\} \quad (\text{Formula 4})$$

where d is the pupil diameter in mm, and L is the average luminance in units, in which Formula 4 is also known as the Stiles-Crawford effect, and Troland is a unit of the retinal illumination, which is utilized to correct photometric measurements of illumination that fall on the retina by scaling them to the effective pupil size. In other words, the illumination falling on the retina of the human eye may be obtained according to the average luminance and the pupil diameter.

Moreover, regarding the signal/noise (S/N) ratio modification, the calculation of the signal/noise ratio modification may be carried out by the following formulas:

$$SNR = \frac{P_{signal}}{P_{noise}} = \left( \frac{A_{signal}}{A_{noise}} \right)^2 \quad (\text{Formula 5})$$

where P is the average power and A is the root mean square (RMS) amplitude. It should be noted that both the signal and noise powers must be measured at the same or equivalent points in a system and measured across the same impedance.

Further, due to many signals have a very wide dynamic range, SNRs are often expressed using the logarithmicdecibel scale, in which the SNR may be defined using amplitude ratios through the following formula:

$$SNR(\text{dB}) = 10 \log_{10} \left( \frac{P_{signal}}{P_{noise}} \right) = 20 \log_{10} \left( \frac{A_{signal}}{A_{noise}} \right) \quad (\text{Formula 6})$$

where P is the average power and A is the root mean square (RMS) amplitude. It should be noted that the signal variable in the formulas may be considered as the light intensity transmitting from the ALA apparatus and received by the indoor person after being reflected by the light blocking layer and the outdoor person, while the noise variable in the formulas may be considered as the light intensity transmitting from the ALA apparatus to the indoor environment without being reflected by the outdoor person.

To be more specific, FIG. 11 schematically illustrates a calculation of signal/noise (S/N) ratio in an ALA apparatus of one of exemplary embodiments of the disclosure in the situation considering the light from backlight layer only. Here, a light blocking layer 1130 and a light guide plate 1160 of the ALA apparatus are illustrated, in which the light guide plate 1160 receives light emitted from the light sources (not shown) and transmits the light to the light blocking layer 1130 towards the indoor environment. Referring to FIG. 11, the luminance outputted from the light guide plate 1160 is indicated as  $L_0$ , and such luminance is changed to  $L_0 T$  (where T is the transmittance of the light blocking layer

18

1130) after the light passes through the light blocking layer 1130, which may be considered as the noise variable in the signal/noise (S/N) ratio.

On the other hand, from the outdoor position 1004 perspective, the luminance  $L_0$  outputted from the light guide plate 1160 may be reflected by the light blocking layer 1130 to become as  $L_0 R$ . Then, the luminance  $L_0 R$  along with the luminance  $L_0$  outputted from the light guide plate 1160 may be reflected as the light reaches the outdoor position 1004, so that the luminance at the outdoor position 1004 has been changed to  $(L_0 R + L_0) \times R_H$ , where  $R_H$  is the human body reflection ratio, 50%, for instance.

Further, from the indoor position 1002 perspective, after the light is reached the outdoor position 1004 and reflected back to the indoor position 1002 through the ALA apparatus, the luminance that the person receives at the indoor position 1002 is  $(L_0 R + L_0) \times R_H \times T$ , which may be considered as the signal variable in the signal/noise (S/N) ratio. As such, the signal/noise (S/N) ratio for a viewer indoor may be estimated through the following formula:

$$\frac{S}{N} = \frac{(L_0 + L_0 R) \times R_H \times T}{L_0 T} = \frac{(1 + R) \times R_H}{1}, \quad (\text{Formula 7})$$

where the signal/noise (SN) ratio is configured to be less than 10 in the disclosure, that is,  $(1 + R) \times R_H / 1 \ll 10$ .

In contrast, the signal/noise (S/N) ratio for a viewer outdoor may be estimated through the following formula:

$$\frac{S}{N} = \frac{(L_0 T) \times R_H \times T}{L_0} = \frac{T^2 \times R_H}{1} < 1 \quad (\text{Formula 8})$$

It should be noted that a signal/noise (SN) ratio threshold for a viewer indoor may be arranged between 5 and 1000 and a signal/noise (S/N) ratio threshold for a viewer outdoor may be arranged below 1 as the light sources and light blocking layer of the ALA apparatus are disabled. Based on the above, in the embodiments of the disclosure taken such factors into consideration, the light blocking layer(s) may be employed to control the light blockage levels so as to adjust the ambient light characteristics between the indoor and outdoor positions, in which the light blockage levels may be further controlled when the pre-set pattern of the light blocking layer(s) is configured, so that the light blocking layer is partially or entirely adjusted with the various light blockage levels thereon in order to block the desired view or view angle between the indoor and outdoor positions. Moreover, besides the light guide plate with specified refractive index, the diffusion layer(s) may be equipped with the light guide plate to diffuse and reflect the light emitted from the light sources. As such, a desired degree of privacy may be achieved through the afore-described components of the ALA apparatus (that is, the light blocking layer, the light guide plate and the diffusion layer). By this way, the ALA apparatus of the disclosure may be served as various modes for the privacy of the indoor environment. The following descriptions are further illustrated individual mode which the ALA apparatus can be served.

FIG. 12A through FIG. 12D schematically illustrate various modes that an ALA apparatus being served in one of exemplary embodiments of the disclosure. Here, the ALA apparatus depicted in FIG. 2A is employed for illustration,

19

in which the main body is sandwiched in between two light blocking layers, although the disclosure is not limited thereto.

Referring to FIG. 12A, the ALA apparatus **1200A** separates the indoor and outdoor environments, in which the indoor environment includes an indoor light source **1206** and the outdoor environment includes an outdoor light source **1208**, where the outdoor light source **1208** provides same light intensity as the indoor light source **1206**.

In this embodiment, either one or both of the light blocking layers of the ALA apparatus **1200A** may be partially or entirely adjusted with the light blockage levels respectively thereon via the micro controller **1210**, and/or, either one or both of the light blocking layers may be adjusted independently or correlated with each other through the micro controller **1210**, in which the pre-set patterns of the light blocking layers may be arranged as that of depicted in FIG. 4A through FIG. 4D to adjust the light blockage levels. Through the light blocking layers of the ALA apparatus **1200A**, a ratio of the light transmittance and the light reflection may be obtained (for instance,  $T/R=9/1$ ), such that the indoor ambient light is equivalent to the outdoor ambient light. By this way, the persons respectively at the indoor and outdoor positions **1002**, **1004** are able to see each other through the ALA apparatus **1200A** with the outdoor light source **1208** provides same light intensity as the indoor light source **1206**. In this case, the mode of the ALA apparatus **1200A** may be regarded as a regular window, for instance.

Referring to FIG. 12B, the ALA apparatus **1200B** separates the indoor and outdoor environments, in which the indoor environment includes an indoor light source **1206** and the outdoor environment includes an outdoor light source **1208**, where the outdoor light source **1208** provides same light intensity as the indoor light source **1206**.

In this embodiment, either one or both of the light blocking layers of the ALA apparatus **1200B** may be partially or entirely adjusted with the light blockage levels respectively thereon via the micro controller **1210**, and/or, either one or both of the light blocking layers may be adjusted independently or correlated with each other through the micro controller **1210**, in which the pre-set patterns of the light blocking layers may be arranged as that of depicted in FIG. 4A through FIG. 4D to adjust the light blockage levels. Through the light blocking layers of the ALA apparatus **1200B**, the light transmittance may be configured to be zero (that is,  $T=0$ ), such that the ambient lights of the indoor and outdoor environments are completely blocked by the ALA apparatus **1200B**. In other words, the ALA apparatus **1200B** may be in a total reflection state. By this way, the persons respectively at the indoor and outdoor positions **1002**, **1004** are unable to see each other through the ALA apparatus **1200B**, from both the indoor and outdoor perspectives, regardless the indoor and outdoor ambient light intensities. For example, the person at the indoor position **1002** is incapable of seeing the person at the outdoor position **1004** through the ALA apparatus **1200B**. Similarly, the person at the outdoor position **1004** is incapable of seeing the person at the indoor position **1002** through the ALA apparatus **1200B**. In this case, the mode of the ALA apparatus **1200B** may be regarded as a shutter and/or curtain being drawn down, for instance.

Referring to FIG. 12C, the ALA apparatus **1200C** separates the indoor and outdoor environments, in which the outdoor environment includes an outdoor light source **1208** whereas the indoor environment has no indoor light source provided. That is to say, the indoor environment is in a darker state than the outdoor environment.

20

In this embodiment, either one or both of the light blocking layers of the ALA apparatus **1200C** may be partially or entirely adjusted with the light blockage levels respectively thereon via the micro controller **1210**, and/or, either one or both of the light blocking layers may be adjusted independently or correlated with each other through the micro controller **1210**, in which the pre-set patterns of the light blocking layers may be arranged as that of depicted in FIG. 4A through FIG. 4D to adjust the light blockage levels. Through the light blocking layers of the ALA apparatus **1200C**, a ratio of the light transmittance and the light reflection may be obtained (for instance,  $T/R=1/9$  or  $2/8$ ), such that a portion of the ALA apparatus **1200C** has become highly reflective and the indoor ambient light is far less than the outdoor ambient light. By this way, the person at the outdoor position **1004** is unable to see the indoor environment whereas the person at the indoor position **1002** remains the ability to see the outdoor environment, through the ALA apparatus **1200C** with a specific  $T/R$  ratio. In this case, the mode of the ALA apparatus **1200C** may be regarded as a one-way mirror of an interrogation room, for instance.

Referring to FIG. 12D, the ALA apparatus **1200D** separates the indoor and outdoor environments, in which the indoor environment includes at least two indoor light sources **1206** and the outdoor environment includes an outdoor light source **1208**. That is to say, the indoor environment is in a brighter state than the outdoor environment. It should be noted that as long as the indoor environment is brighter than the indoor environment, the quantity of the indoor light sources **1206** is not limited to the embodiment.

In this embodiment, either one or both of the light blocking layers of the ALA apparatus **1200D** may be partially or entirely adjusted with the light blockage levels respectively thereon via the micro controller **1210**, and/or, either one or both of the light blocking layers may be adjusted independently or correlated with each other through the micro controller **1210**, in which the pre-set patterns of the light blocking layers may be arranged as that of depicted in FIG. 4A through FIG. 4D to adjust the light blockage levels. Through the light blocking layers of the ALA apparatus **1200D**, a ratio of the light transmittance and the light reflection may be arranged to satisfy a specific relationship (namely,  $T<R$ ) in a manner that the regions of the light blocking layers being all modified or being spatial multiplexed, such that the ratio of the light transmittance and the light reflection may be controllable to adjust the indoor and outdoor ambient lights in order for the ALA apparatus **1200D** to become partially reflective. By this way, the person at the outdoor position **1004** is unable to see the indoor environment whereas the person at the indoor position **1002** remains the ability to see the outdoor environment, through the ALA apparatus **1200D** with a controllable  $T/R$  ratio, in particular, the indoor environment is brighter than the outdoor environment. In this case, the mode of the ALA apparatus **1200D** may also be regarded as a one-way mirror illustrated in FIG. 12C, however, the differences between the embodiments depicted in FIG. 12C and FIG. 12D are that the ALA apparatus **1200C** has a fixed  $T/R$  ratio and the indoor environment requires to be darker than the outdoor environment, by contrast, the ALA apparatus **1200D** has a controllable  $T/R$  ratio which allows the ALA apparatus **1200D** to function as the ALA apparatus **1200C** (such as one-way mirror) under the circumstances that the indoor environment is brighter than the outdoor environment.

More specifically, FIG. 13A and FIG. 13B schematically illustrate an use of decodable light and an use of both decodable light and light blocking layer in the ALA appa-

21

ratus depicted in FIG. 12D, respectively. Here, the ALA apparatus 1200D depicted in FIG. 12D is employed for illustration, in which the main body is sandwiched in between two light blocking layers 1330 and 1340, although the disclosure is not limited thereto.

Referring to FIG. 13A, one of the light blocking layers (e.g. 1330) is partially adjusted with the light blockage levels thereon through the micro controller 1310, in which the pre-set pattern of the light blocking layer 1330 may be arranged as one of depicted in FIG. 4A through FIG. 4D. For the illustration purpose, the pre-set pattern of the light blocking layer 1330 may be arranged as one area having high transmittance (such as, a transparent area) and one area having high reflection (such as, a block area) cross-sectionally, as shown in FIG. 13A.

In the embodiment, the indoor position 1002 is close to the ALA apparatus 1300A, and the outdoor position 1004 is further away from the ALA apparatus 1300A. For example, the distance d1 between the indoor position 1002 and the ALA apparatus 1300A is between 0.1 m and 0.3 m, while the distance d2 between the outdoor position 1004 and the ALA apparatus 1300A is between 3 m and 5 m. On the other hand, the light blocking layer 1340 may be entirely adjusted with the light blockage levels thereon through the micro controller 1310 to be totally transparent. Besides, the indoor environment includes at least two indoor light sources 1306 and the outdoor environment includes an outdoor light source 1308. The quantity of the indoor light sources 1306 is not limited to the embodiment, as long as the indoor environment is brighter than the indoor environment.

Under such configuration of the ALA apparatus 1300A, the person at the indoor position 1002 is able to see the outdoor environment through one transparent area of the light blocking layer 1330. However, the person at the outdoor position 1004 is vaguely able to see the profile of the person at the indoor position 1002 through the transparent area of the light blocking layer 1330 due to the view angle and the distance between the outdoor position 1004 and the ALA apparatus 1300A. In other words, the outdoor person may see the indoor person as a profile image with a mask thereon in the condition that the indoor environment is brighter than the indoor environment, thereby improving the privacy of the indoor environment.

Referring to FIG. 13B, similar to the embodiment depicted in FIG. 13A, the difference between the two embodiments is that the light blocking layers 1330 and 1340 of the ALA apparatus 1300B are both partially adjusted with the light blockage levels thereon through the micro controller 1310, in which the pre-set patterns of the light blocking layers 1330 and 1340 may be respectively arranged as one of depicted in FIG. 4A through FIG. 4D, where the selected pre-set patterns may be different to each other. For the illustration purpose, the pre-set patterns of the light blocking layers 1330 and 1340 may be respectively arranged as one area having high transmittance (such as, a transparent area) and one area having high reflection (such as, a block area), in which the transparent areas of the light blocking layers 1330 and 1340 are not aligned with each other.

Under such configuration of the ALA apparatus 1300B, the person at the indoor position 1002 remains the ability to see the outdoor environment through the transparent areas of the light blocking layers 1330 and 1340. However, in this case, the person at the outdoor position 1004 due to the view angle is incapable of seeing the indoor environment through the transparent areas of the light blocking layers 1330 and 1340. In other words, the outdoor person is unable to see the indoor environment through the uses of decodable light and

22

light blocking of the ALA apparatus 1300B, in the condition that the indoor environment is brighter than the indoor environment, thereby further enhancing the privacy of the indoor environment.

Please refer to FIG. 14, which schematically illustrates a blocking view example with a spatial multiplexed manner by using one mask in an ALA apparatus of one of exemplary embodiments of the disclosure. In one embodiment, a light blocking layer in the ALA apparatus or in the system is partially or entirely adjusted with the light blockage levels for blocking the view between the indoor position and the outdoor position manually or automatically under the control by the controller. For example, an original image 1410 in the indoor position will be blocked by the spatial multiplexed manner through the mask 1420 and then became two different images 1430 and 1440 from different view angles in the outdoor position.

Please refer to FIG. 15, which schematically illustrates a blocking view example with a time multiplexed manner by using two masks in an ALA apparatus of one of exemplary embodiments of the disclosure. In one embodiment, a light blocking layer in the ALA apparatus or in the system is partially or entirely adjusted with the light blockage levels for blocking the view between the indoor position and the outdoor position manually or automatically under the control by the controller. For example, an original image 1510 in the indoor position will be blocked by the time multiplexed manner through two masks 1520, 1530 and then became two different images 1540 and 1550 from different view angles in the outdoor position.

Please refer to FIG. 16-FIG. 18, which schematically illustrate a plurality of methods of adjusting an refractive index of a light guide plate in an ALA apparatus of one of exemplary embodiments of the disclosure. In one embodiment, the light guide plate is embedded or imprinted with light diffusible particles to have a desired refractive index. The refractive index of light guide plate may be in a range from about 1.2 to about 2.5. The size of the diffusible particles is in a range from about 0.1  $\mu\text{m}$  to about 2  $\mu\text{m}$ . The materials of light diffusible particles are selected from the group consisting of  $\text{SiO}_2$ ,  $\text{SiO}$ ,  $\text{TiO}_2$ ,  $\text{ZrO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{ZnS}$ ,  $\text{Si}_3\text{N}_4$ ,  $\text{MgF}_2$ , or combination thereof.

Please refer to FIG. 16, a physical method may be provided to improve the refractive index of the light guide plate. In the physical method, the light guide plate may be processed by using plasma materials, and a plurality of micro structures 1620 are formed after using the ions bombing on the surface of the light guide plate 1610. The plurality of micro structures 1620 may fix the Nano-sized light diffusible particles disposed therein. The refractive index of a light guide plate by using the micro structure 1620 may provide the refractive index with a normal distribution or a Gaussian distribution.

Please refer to FIG. 17A and FIG. 17B, a self-assembly monolayer (SAMs) 1710 with a pre-determined pattern is formed on a surface of a light guide plate. The SAMs 1710 may be manufactured by using physical vapor deposition techniques, electrodeposition or electroless deposition. The SAMs 1710 are useful in depositing nanostructures, because each adsorbate molecules 1720 thereon can be tailored to attract materials such as particular nanoparticles. The functional groups using in the SAMs 1710 may be thiol, N-hydroxy succinimide (NHS) group, amino group, aldehyde group, epoxy group, carboxyl group, hydroxyl group, acyl group, acetyl group, hydrazono, hydrophobic group, thiol group, photoreactive group, cysteine group, disulfide group,

23

alkyl halide group, acyl halide group, azide group, phosphate group, or combination thereof.

Please refer to FIG. 18, a method of using a matrix with particles implanted therein to improve the refractive index of the light guide plate is provided herein. A plurality of areas (I) desired to be implanted or mixed with more particles is pasted first and then a plurality of areas (II and III) on the desired to be implanted or mixed with less particles is pasted thereafter. The light guide plate is pre-baked. A thermal-curing process is performed on the light guide plate.

It will be apparent to those skilled in the art that various modifications and variations can be made to the structure of the disclosed embodiments without departing from the scope or spirit of the disclosure. In view of the foregoing, it is intended that the disclosure cover modifications and variations of this disclosure provided they fall within the scope of the following claims and their equivalents.

What is claimed is:

1. An Ambient light adjustment (ALA) apparatus, comprising:

a main body, having a plurality of edges, a first surface and a second surface opposing to the first surface, wherein the main body comprises a light guide plate; at least one light source, mounted on at least one edge of the main body, wherein the light guide plate receives a side light from the at least one light source and guides the side light into a planar light emitted from the light guide plate;

a first light blocking layer, disposed over the first surface of the main body;

a controller, coupled to the light source and the first light blocking layer, the controller controlling light characteristics of the light source and light blockage levels of the first light blocking layer to adjust ambient light characteristics; and

a second light blocking layer disposed over the second surface of the main body,

wherein at least one of the first light blocking layer and the second light blocking layer having a plurality of controllable blocking areas is a decodable light blocking layer for programming spaces, frequencies and degrees of light blockage.

2. The ambient light adjustment apparatus of claim 1, wherein the light guide plate has a first surface and a second surface.

3. The ambient light adjustment apparatus of claim 2, wherein the material of the light guide plate comprises acrylic resin, polycarbonate, epoxy, or glass.

4. The ambient light adjustment apparatus of claim 2, wherein the main body further comprises at least one diffusion layer formed on the first surface of the light guide plate.

5. The ambient light adjustment apparatus of claim 4, wherein the diffusion layer is selected from one of the group consisting of a self-assembled monolayer, a particle-embedded layer, a micro-machined structure layer and a printed dot-pattern layer.

6. The ambient light adjustment apparatus of claim 2, wherein the light guide plate is embedded or imprinted with light diffusible particles.

7. The ambient light adjustment apparatus of claim 1, wherein the first light blocking layer and the second light blocking layer are electro-chromatic layers or electro-wetting layers.

8. The ambient light adjustment apparatus of claim 1, wherein the first and second light blocking layers are

24

selected from the group consisting of an electro-chromatic layer and an electro-wetting layer.

9. The ambient light adjustment apparatus of claim 1, wherein a third light blocking layer is forming on the second surface of the main body.

10. The ambient light adjustment apparatus of claim 1, further comprising:

a sensor, coupled to the controller, wherein the controller controlling the light characteristics of the light source and/or the light blockage levels of the first light blocking layer according to a sensed result by the sensor.

11. The ambient light adjustment apparatus of claim 10, wherein the sensor comprises a plurality of multiple spectrum sensing units.

12. The ambient light adjustment apparatus of claim 1, wherein the controller further integrated with a sensor, wherein the controller controlling the light characteristics of the light source and/or the light blockage levels of the first light blocking layer according to a sensed result by the sensor.

13. The ambient light adjustment apparatus of claim 12, wherein the sensor comprises a plurality of multiple spectrum sensing units.

14. The ambient light adjustment apparatus of claim 1, wherein the light characteristics comprise light intensity and light color temperature.

15. The ambient light adjustment apparatus of claim 1, wherein the light source comprises a plurality of multiple spectrum light sources.

16. The ambient light adjustment apparatus of claim 1, further comprising a second main body having a plurality of edges, a first surface and an second surface opposing to the first surface, wherein the second main body, dispose on a surface of the first light blocking layer opposing to another surface of the first light blocking layer facing the main body, wherein at least one of the light sources mounted on at least one edge of the second main body.

17. The ambient light adjustment apparatus of claim 16, wherein the second main body comprises a second light guide plate with a first and a second surface.

18. The ambient light adjustment apparatus of claim 17, wherein the second main body further comprises at least one diffusion layer formed on the second surface of the second light guide plate.

19. A method for the ambient light adjustment apparatus as claimed in claim 1 to adjust indoor ambient light characteristics, the method comprising:

sensing indoor light characteristics;

comparing the sensed indoor light characteristics with a pre-set threshold; and

adjusting the indoor ambient light characteristics based on the at least one pre-set threshold by performing at least one of the following steps:

adjusting a degree of blockage of the first and second light blocking layers;

adjusting light characteristics of the light source; and

adjusting light characteristics of an indoor light source.

20. An transparent ambient light adjustment (ALA) apparatus, comprising:

a main body having a plurality of edges, a first surface and an opposing second surface, wherein the main body comprises a light guide plate;

at least one light source mounted on at least one edge of the main body, wherein the light guide plate receives a side light from the at least one light source and guides the side light into a planar light emitted from the light guide plate;

25

a first light blocking layer formed on the first surface of the main body;  
 a second light blocking layer formed on the second surface of the main body;  
 a sensor; and

a controller coupled to the sensor, the main body, the light source and the light blocking layer, the controller controlling ambient light characteristics by controlling the at least one light source and by adjusting light transmittance ratio and reflection ratio of the main body and the light blocking layer in response to a sensed result of the sensor, wherein the light transmittance ratio is ranged from 95% to 0%, and the reflection ratio is ranged from 5% to 100%,

wherein at least one of the first light blocking layer and the second light blocking layer having a plurality of controllable blocking areas is a decodable light blocking layer for programming spaces, frequencies and degrees of light blockage.

21. The transparent ambient light adjustment apparatus of claim 20, wherein the light guide plate having a first surface and a second surface is attached on the main body spatially.

22. A system for adjusting indoor ambient light characteristics, the system comprising:

an indoor ambient light adjustment (ALA) apparatus comprising:

a main body, having a plurality of edges, a first surface and a second surface opposing to the first surface, wherein the main body comprises a light guide plate;  
 at least one light source, mounted on at least one edge of the main body, wherein the light guide plate receives a side light from the at least one light source and guides the side light into a planar light emitted from the light guide plate;

a first light blocking layer, disposed over the first surface of the main body;

a second light blocking layer, disposed over the second surface of the main body;

a controller, coupled to the light source and the first light blocking layer and the second light blocking layer; and

an outdoor sensor and an indoor sensor for sensing the ambient light characteristics and sending sensed results to the controller,

wherein the controller is programmed with at least one pre-set threshold, and the controller adjusts light characteristics of the light source and light blockage levels of the first and second light blocking layers based on the pre-set threshold and the sensed results by the outdoor sensor and the indoor sensor,

wherein the first light blocking layer and the second light blocking layer are programmed for displaying a pre-set pattern to have a transmittance and a reflectance based on the sensed results by the outdoor sensor and the indoor sensor, so to have a capability to function as an one-way mirror for the ALA apparatus.

26

23. The system for adjusting ambient light characteristics of claim 22, wherein the controller is further coupled to at least one indoor light source for adjusting indoor ambient light characteristics.

24. The system for adjusting indoor ambient light characteristics of claim 22, wherein the controller further comprises at least one memory unit and/or at least one processor unit.

25. The system for adjusting indoor ambient light characteristics of claim 22, wherein the ambient light adjustment apparatus further comprises a receiver coupling to the controller and a remote control, wherein the remote control transmitting commands to the controller via the receiver.

26. The system for adjusting indoor ambient light characteristics of claim 25, wherein the remote control further comprises:

power supply means for supplying power to the remote control;

keyboard means for inputting system control commands;

control means coupled to the keyboard means and the power supply means for accepting the system control commands and outputting a series of system control signals; and

transmitter means coupled to the control means and the power supply means for transmitting the control signals to the system.

27. The system for adjusting indoor ambient light characteristics of claim 22, wherein the first and second light blocking layers are partially or entirely adjusted with the light blockage levels for blocking the view between an indoor position and an outdoor position.

28. The system for adjusting indoor ambient light characteristics of claim 27, wherein the first and second light blocking layers are manually or automatically adjusted through the controller.

29. The system for adjusting indoor ambient light characteristics of claim 28, further comprises at least one indoor light source to enhance the indoor ambient light characteristics.

30. The system for adjusting indoor ambient light characteristics of claim 22, further comprising one or more programs, the one or more programs being stored in a memory unit and configured to be executed by the controller for conducting:

sensing indoor light characteristics;

comparing the sensed indoor light characteristics with a preset threshold;

adjusting indoor light characteristics based on the comparison; and

conducting at least one of following steps:

tuning the blockage of the first and second light blocking layers;

adjusting the light characteristics of the light source; and

adjusting indoor light characteristics.

\* \* \* \* \*